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ON THE MUTUAL ACTION
OF
LIVING VEGETABLE AND ANIMAL CELLS.

A BIOLOGICAL STUDY.

BY
PROFESSOR TH. BILLROTH.

Translated by
F. A. JUNKER VON LANGEGG, M.D., M.R.C.S., Eng.

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ON THE MUTUAL ACTION OF LIVING VEGETABLE AND ANIMAL CELLS.

A BIOLOGICAL STUDY.

By TH. BILLROTH.

THOSE who have followed with earnest interest the great development of the medical and surgical sciences during recent times certainly will hail with genuine satisfaction the elucidation of so many hazy speculative opinions which, especially on the causes of disease, have been handed down to us by our predecessors. It is scarcely twenty years since what was called "the genius epidemicus and endemicus" of disease, the different character of the healing tendency of wounds during this or that state of the weather, the causation of pyæmia by the emanations of patients affected with suppuration, and of pneumonia by chills, the individual predisposition to this or that disease, had been maintained as undoubted facts. And now, that all this should no longer be true! Now the general shibboleth is: "*Microbes!*" The cause of suppuration in general: "*Microbes!*" The cause of pyæmia: "*Microbes!*" The cause of pneumonia: "*Microbes!*" The cause of the formation of tubercles: "*Microbes!*"

Indeed, the modern pathological anatomy of the present day propounds the theorem, "*Acute and chronic inflammations are almost in every case produced by Microbes.*" Only a few poisons when repeatedly and for a longer period introduced into the body may cause chronic inflammatory processes—*e.g.*, alcohol (cirrhosis of the liver, chronic gastritis), phosphorus (maxillary osteitis). Several substances—viz., cantharides, mustard-oil, petroleum, the oils of turpentine and of croton, and ammonia—call forth to the extent to which they come into contact with tissues acute suppurative inflammations, but without ever producing progressive phlegmonous processes. Cases of accidental application of the last-mentioned substances are so extremely rare that on the whole they may be entirely omitted from the etiology of inflammatory processes. *The inflammations and suppurations, including the common suppuration of wounds, which we meet in medical and surgical practice, are the effects of Microbes.*

It is a hard strain on men of the older and middle-aged generations now to throw overboard all their former convictions, and with these at the same time the enormous lumber of therapeutics suggested by these now discarded views. They must have some misgivings that their medical craft will prove too light, and will drift without helm and compass, as the shipping of the new freight can neither be easily nor speedily enough effected.

I still vividly bear in mind how I myself, though I was in the midst of the movement, and perhaps in some degree its originator, frequently apprehended that it might prove too rapid and one-sided. Certainly surgery has, as regards the therapeutics, carried off the lion's share. I also have very cautiously followed the movement, testing every step and weighing every detail, until I felt fully convinced and became a zealous advocate of the new doctrine, and enthusiastically pursued the new direction. What in the beginning I sadly missed, principles strictly based upon natural science for the methods of the antiseptic operations and treatment, and what I in vain aimed at in my finally abandoned researches on the coccobacteria septica, had afterwards been advised by others in such a successful manner that the anatomico-physiological details of these investigations, as well as the enormous painstaking work enhanced by these researches and its ingenious execution, have evoked in me wondering admiration.

I have already demonstrated in earlier papers on traumatic fever and accidental traumatic affections—at a time when traumatic and inflammatory fevers were still considered as so-called irritative fevers due to nervous action, and when pyæmia was believed to be a miasmatic disease entirely independent of those with which the injured patient may suddenly be seized in a similar manner as with acute traumatic fever—that inflammation, suppuration, and gangrene are intimately connected with traumatic fever, inflammatory fever, pyæmia, and septicæmia, and that they represent analogous processes in a progressive ratio of danger.

This homogeneous arrangement of the traumatic and inflammatory fevers was much more in accordance with the actual conditions than the former views, and soon found general acceptance. What was more natural than to search for a uniform cause which obviously manifested itself in the disintegration of the tissue fluids in the injured and inflamed tissues? In this instance the term "*disintegration*" ("Umsetzung") was accepted in its widest sense. I considered it as a series of changes, the starting-point of which was a most minute disturbance of nutrition called forth by a slight solution of continuity, passing on to suppurative solution of the tissue, and terminating in gangrene and putrefaction. Not only quantitative but also qualitative differences were presupposed in this process. The absorption of the products of disintegration caused general disturbances in the organism, mostly fever, occasionally also dangerous conditions of poisoning without concomitant fever. Thus originated such terms as aseptic fever without reaction during the healing process, simple traumatic fever, suppurative fever, septic fever, sepsis with collapse, &c.

Then also a uniform poison, by the absorption of which these conditions were called forth, was searched after, and was presumed to originate in purulent matters (*Panum's* and *Bergmann's* "sepsin").

But when the conviction became more and more generally accepted that putrefaction, like fermentation, is brought on by very minute living organisms, and when *Pasteur*, by his important investigations in this direction, by new methods opened new roads, contrary to those of *Liebig*, whose authority as a chemist had hitherto seemed to me of greater weight and more acceptable than that of Pasteur, I could not, and even now cannot, discard the opinion that every organic tissue, as soon as life is extinguished, or is materially interfered with, must in accordance with its surroundings enter upon a new mode of change of matter, as it is certainly unable to maintain itself unaltered under these totally different conditions; there cannot, therefore, in my opinion, exist also a transformation of decaying and decayed tissue without the influence of microbes. The absorption of such kinds of products of decomposition of diseased, *i.e.*, decayed tissues, was, according to my former views, the sole cause of primary traumatic and inflammatory fever. If this, moreover, led to the death of tissue—to gangrene—then the microbes, which in wounds and other focuses of inflammation

I considered as saprophytes, appeared and produced that condition generally known as fetid putrescence. By the transmission of these microbes into suppurating wounds, into the urine and the saliva, after they had been accustomed to a certain change of matter in putrid tissue fluids, they likewise could, when taken up in suppurating wounds, in the urine and the saliva, call forth processes of fermentation and putrescence, and thus become secondary causes of disease.

Influenced, I willingly admit, by the authority of my friend *Griesinger*, I regard the microbes as the undoubted *vehicles* of contagia, but I had not yet conceived the now generally current idea of "*pathogenic bacteria*." Though the anthrax bacilli were already known, there was still much divergence of opinions on their significance.

How then are these microbes constituted? In what manner do they act? How do they behave in fermentation? How in putrescence? There was then a chaos of the most minute living organisms known by the name of "*Infusoria*"; from these we had to start in our investigations. The "*Vibriones*" were still considered by the majority of physicists to be animalculi; the notion of the "*Swarm-spores*" ("Schwärm-Sporen") of plants had scarcely yet found its way into medical circles. Now-a-days, when everything has been so well arranged and classified, no one can form an idea of the amount of pains and difficulties it caused to me gradually to separate the individual forms of Cocci and Bacteria, to construe the terms Coccus, Diplococcus, Streptococcus, Streptobacteria, Gliacoccus, Petalococcus, and Ascococcus, to recognise that they are composed of a plasma and a wall, to trace their conditions of growth, and finally clearly to understand that they belong to the *Algæ*, that *Zygo-spores* or *Resting-spores* ("Dauer-Sporen") and *Vacuoli* form in them, that they are liable to vesicular degenerations, and that their membranes sometimes develop into thick mucous investments, and in what manner this can to a certain degree be brought about by the nutritive medium ("Nährboden"), &c. Each newly appearing form led again in a roundabout way to new investigations on the Algæ and Fungi, in order to gain somehow a morphologic support. The whole task was carried out on too broad a basis, it was far beyond my botanical and chemical knowledge. No one could more keenly feel the shortcomings of his work than I. They may only be compared with the explorations of an insufficiently instructed traveller in a country still very little known. I therefore was obliged, in order not to lose the little I had achieved, to stop short, and I constructed a typical form, "the *Coccobacteria septica*," from which I imagined the majority of the other forms which came within the range of my investigations were derived. I was supported in my speculations by the dawning *Darwinism*, and the authority of *Naegeli*. I wound up, as regards etiology, with the hypothesis, "the products of inflammation" (the first origin of which in most cases still remained to me as obscure as before), specially the ferment which I conjectured to exist in them, "the *Zymoide*"—are a particularly favourable nutritive medium for the whole progeny of the Coccobacteria group which gain entrance partly from outside, partly from the blood. Here they luxuriate and by their intrinsic vital activity increase the inflammatory process and materially contribute to its progress. They undergo in each focus of inflammation a certain change of matter and transfer it, when entering another living tissue, into the latter.

The normal uninjured surface of the body is protected against the invasion of these elements. The dried microbes only act when converted into resting-spores, and when, after their ingress into the animal body, they find sufficient water to enable them to swell out and germinate.

What next strongly impressed me on this subject was the *inoculation* of putrescent fluids containing microbes into the *living cornea*. What had hitherto seemed to me a hypothesis, viz., that cocci may be capable of finding their way also into healthy tissues and thus to overpower and destroy the vital energy of the tissue-cells, has in this instance become a proved fact. At the same time another phenomenon became evident: that the effect on the cornea of dogs was very slight, but on the cornea of rabbits in many cases totally destructive. But as the same star-shaped figures, as shown by the investigations of *A. von Frisch*, likewise appeared on the dead cornea, these inoculated cocci might also be genuine saprophytes, which, owing to a peculiar vegetative energy in the living cornea, only gained more permanent hold, and this view is supported by the considerable differences of reactive processes observed in the living cornea of rabbits. These investigations were followed by the more and more interesting results of inoculation with *Anthrax bacteria*, and finally by *Koch's* new methods of cultivating microbes on solid nutritive mediums, which, for the time, explains the preceding observations, and thus within a short time the idea of "*specific pathogenic bacteria*" became fully established, almost like Minerva sprung from Jupiter's brains. Even then I still hesitated; we only become partially acquainted by these experiments with the amphibious nature of these Algæ; their behaviour against pigments offers only an external evidence. Chemists always mistrust a chemical substance which is only known by its reactions, they demand an elementary analysis. We in like manner ought to survey the development of microbes in all their stages before we are justified in saying that we thoroughly know them. What we at present individualise by colouration as specific pathogenic forms, may be very deceptive characteristics of generic differences. Algæ are by their nature genuine aquatic plants; may not many of those which at present we distinguish as separate genera prove themselves to be merely different stages of a still unknown series of successive developments? Need I remind you of the formerly unsuspected connection between Tape-worm, Cysticercus and Echinococcus; of the history of the Pencillium; of so many Pleomorphisms; of the Parthogenesis through numerous generations; of the manifold larval conditions of insects; of the sea-stars, &c.? We still are uncertain whether we have to consider the different forms of the yeast plant as occasional vegetative forms of Fungus spores in fluids, or as a special genus of plant.

All these considerations, however, become of but minor importance in view of the immense progress achieved, especially in etiologico-pathological respect, by the methods of *Koch* and his followers. The number of observations systematically pursued is overwhelming. A summary collection of these by *Baumgarten* in his classical work ("*Manual of pathological Mycology*" *) raises our imagination into the loftiest regions of a reliable etiology of the future, especially as regards the inflammatory processes and the zymotic diseases. It is a charm equal to the highest artistic enjoyment, to give oneself to the study of such a book with the warmest enthusiasm, as it contains the summary of the best scientific minds of our time. Where a vigorous movement towards progress commences it is perceived by minds which, irresistibly attracted by this movement, are at first carried away by it and soon themselves turn the wheels by the force of their own labour. This we have witnessed in Histology, in the history of evolution, in Pathological Anatomy and Histology, in Physiology and in Surgery.

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* "Lehrbuch der pathologischen Mykologie." Braunschweig, 1890.

We shall now consider the views which have been formed on the relation of "*Pathogenic Microbes*" to the tissues of the animal body.*

We must, above all, clearly understand that *only a growing and multiplying organism* can become dangerous to the healthy animal living tissue, and that only in the case *when its assimilative energy is more intense than that of the tissue-cells.* The cocci and bacteria, after their ingress into the respective tissue fluids, must not only be able to live, to continue their existence, but they must also be *stimulated by their reception to an energetic activity of growth, to vigorous reproduction.* One might here already say, *the products of change of matter of the animal tissue cells furnish the formative stimulus for the vegetable cells (the microbes)* in a manner the reverse of what takes place in the formation of galls, of which anon.

It will scarcely be of any importance what the microbes add *by their probable inherent poisons.* The effects of their growth can at first merely be *purely mechanical.* I shall not underrate the effect on tissues like the cornea; the sundering of the lamellæ certainly will cause a very material disturbance of nutrition. But this effect is strictly local, and in other kinds of tissues does not come into consideration. The chemical effects, however, are of much higher importance. We believe they are as follows:—

1. Microbes deprive the tissues of a great portion of their special nutritive fluids. The tissues are starved, they atrophy—genuine parasitism—certainly an extremely rare occurrence in animal tissues, because the growth of microbes can barely be imagined without an influence on the tissues of their change of matter, which must never be lost sight of.

2. Microbes deprive the tissue fluids of certain indispensable

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*I should like to propose a more general use of the word "*Microbes*" as a collective term. I fail to understand that the collective term "*Bacteria*" should also include the "*Cocci*." It seems to me altogether contrary to the sense to designate a *globe* by the Greek name of a *rod*, "Βακτηρια," and to employ the Latin translation "*Bacillus*" for a subdivision of "*Bacteria*."

constituents; what is left to the tissues is either absolutely insufficient for their existence, or produces in them abnormal conditions, *e.g.*, softening or coagulation.

3. Microbes produce secretory matters which call forth an abnormal condition in the tissues, and eventually directly destroy them.

4. The products of change *(Ptomaines, Brieger)* enter into the blood and act as poisons, *e.g.*, on the nervous system; or they directly cause decomposition of the blood, which only slowly or not at all is neutralised. These effects on the blood also cease with the action of the microbes on the diseased part.

5. Microbes find their way into the blood, fix themselves in the capillaries at odd places, produce here new focuses of disease, from which result the same effects on the blood as from the primary focus, *i.e.*, they set up metastasis.

6. The microbes enter into the blood, live and multiply in the circulating blood, and starve, or poison, or decompose it.

I do not assert that herewith all the possible effects of the action of the microbes, which, until lately, we always considered merely as *destructive*, are exhausted, but the principal points of our idea may hereby be indicated, as they of course can enter into manifold combinations with each other.

These conclusions were followed by communications on the Lepra-bacilli *(Klebs)*, on the Scleroma-bacilli *(A. von Frisch)*, as excitants of proliferation of connective tissue, which at once upset the notions which we hitherto had entertained on the purely destructive effects of the microbes. We suddenly found ourselves face to face with the fact *that vegetable cells can act as a purely formative stimulus on the animal tissue cells.* Now followed the most recent observations on the formation of tubercles, and of the nodules of Charbon by the action of bacilli, which at first act as a formative stimulus on the fixed corpuscles of the connective tissue, then produce increased vascularity, eventually suppuration in the circumference, and finally cause necrosis of the primary new formation. Likewise a combination of hyperplasia with inflammation and necrosis. This kind of action of growing vegetable cells on animal cells presents a most remarkable phenomenon, which, in the following, I shall endeavour to treat of more explicitly.

But before we continue, may I be permitted to speak of some phenomena which had been brought to our knowledge by the latest investigations as regards the etiology of inflammation? The alterations which tissues undergo in acute inflammation are fairly known. We are acquainted with the inflammations of surfaces, as *acute catarrhs*, as *blennorrhœas*, in which the white blood corpuscles emigrate in masses from the blood-vessels, the epithelium more rapidly exfoliates, the vessels become larger, and the glands more copiously secrete. We know the *croupous inflammations*, in which fibrine forms on the surface of membranes. We know the *diphtheritic inflammations*, in which the formation of superficial fibrinous membranes is associated with coagulation of the tissue fluids; this coagulation again partially resolves, but may also lead to necrosis of the whole affected tissue. We likewise know the *phlegmonous process*, which rarely resolves without suppuration, frequently terminates in coagulation of the tissue fluids, in partial necrosis of the connective tissue with formation of abscesses, sometimes also in gangrene of the skin, in which after the arrest a process of regeneration follows, which finally ends in cicatrisation.

Formerly the causes of these processes had barely been explained. Now we know that they *always* are called forth by *microbes*, and almost exclusively by *cocci*, which either immigrate from the outside (the diphtheria cocci also through the hair-bulbs in the uninjured skin) or from the blood (where they may be present in infinitesimal numbers), and sometimes enter into the previously injured or diseased tissues, but may also enter into perfectly healthy tissues (spontaneous osteo-myelitis).

But what seems to me most remarkable is the fact that these conditions, which we hitherto have generally considered as different degrees of one and the same process, are caused by *entirely different kinds*, although morphologically related genera, *of cocci*. Thus we have the *Blennorrhœal* (gonorrhœa) *coccus*, which merely produces the egress of leucocytes accompanied by slight hyperæmia, but never leads to parenchymatous processes. Further, we have the *coccus of pneumonia* and *diphtheria*, which sets up inflammation with formation of fibrine. We have the very frequent *Staphylococcus pyogenes aureus*, which engenders the majority of phlegmons and abscesses and endocarditis. We have the *Staphylococcus pyogenes albus*, which, forming a milky-white pulp, corrodes the tissues; the *Streptococcus pyogenes*, which more frequently is met with in suppurating cavities, and very probably is identical with the *Erysipelas coccus*, &c. In short, *there is a special form of coccus for every kind of inflammation*, which again may become more or less dangerous in proportion to its vegetative energy. The whole of our antiseptic art consists in the successful exclusion from wounds of these ubiquitous microbes, which not only vegetate within, but also outside the animal organisms (and are at the same time both saprophytic and pathogenic). If we succeed in that, there will be no suppuration even in the most extensive losses of substance; there will only be regenerative processes, which are entirely independent of microbes. And here we meet with the most remarkable phenomenon of immunity or resistance of certain kinds of animals against these microbes. The pus-cocci vegetate in no animal so well as in man; in the dog, *e.g.*, only with extreme difficulty. Indeed, every new experience in this field raises new problems. At any rate, these experiences on the most eclectic peculiarity of the action of vegetable cells on the tissues of different kinds of animals is in the highest degree remarkable and interesting, and continually recalls to us new mysteries of the cell life in the face of which our chemical knowledge fails.

It seems in some cases as if animal cells would directly be poisoned by the secretion accompanying the growth of the vegetable cells. In other cases, *e.g.*, in the blennorrhœic process, the connection of the capillary walls appears to become loosened so that the leucocytes more easily find egress. Or are these perhaps even attracted by the Blennorrhœal coccus through the capillary walls? Other kinds of coccus again loosen the capillary walls in such a manner that they permit the more easy escape especially of the red blood corpuscles, that perhaps they more readily tear, in short that they invest the morbid processes with a hæmorrhagic character. Other kinds of Microbe cause coagulation of the fluids on the surface of the tissues, others within the interstices of the tissues, others again render the coagulated blood of the thromboses in the vessels mucoid, or soften it into puriform pulp, whilst others again convert the connective tissue into a soft gelatinous state (a kind of peptonisation), which may take its course with or without profuse extravasation of leucocytes. There consequently exist specific forms of cocci, or at least different degrees of their vegetative energy, for every form, almost for every stage, of inflammation, suppuration, and necrosis.

And now, in what manner, and for what reason, do such processes of microbic proliferation terminate? Various suggestions have been offered on this subject. We have long been acquainted with the manner and the mode in which the amœbas encompass with their plasma minute bodies and their immediate surroundings, how they take them up, sometimes digest and also again eject them. We know that the leucocytes behave exactly in the same manner as the amœbas, also when after their emigration they had been converted into pus-corpuscles by the trifoliated fission ("Kleeblattfurchung") of their nucleoli. Moreover, they frequently have been fed without impairment of their vitality with the most subtile carmine or cinnabar granules for the purpose of special examination. In like manner it has been observed that leucocytes receive within themselves, amongst others, also vegetable microbes, cocci and bacteria, and that either they are poisoned by, or kill and digest them. *Metschnikoff* most accurately investigated these processes, and called those cells which devour the microbes by the name of "*Phagocytes*." It, however, seems very doubtful, and is most emphatically contradicted, particularly by *Baumgarten*, that this manner of death of the microbes, which moreover seems not to be all too common, constitutes a very essential cause for the cessation of the processes which are set up by microbic vegetations. Another cause may prove of greater importance. It is an universal law for organised beings that they cannot live in the final products of their change of matter. The ferment cell perishes in the alcohol which it has produced from the sugar; the bacteria of putrescence die in the putrid products of decomposition into which they have split up the albuminous substances. Man dies in the carbonic acid which he expires if the further supply of fresh oxygen is cut off.

The fermentation fungi in the products of this change of matter gradually become less and less vigorous in their chemical action; they sink to the bottom, and their vegetation ceases long before all the sugar has been converted into alcohol and carbonic acid, and long before the nitrogen, which is necessary for their existence, has been used up. In consequence of this vegetative exhaustion, other kinds of fungi settle in the alcoholic solution, and convert the alcohol into acetic acid. In most cases during rapid fermentation the acid fermentation soon commences alongside the alcoholic fermentation. The same thing takes place in the transition of lactic into butyric acid fermentation, &c. If we apply the same notion, *e.g.*, to a phlegmonous process set up by the Staphylococcus aureus, we may presume that the coccus vegetation which in healthy tissue fluids energetically thrives and rapidly spreads into the interstices of the tissue, will sooner or later partly be destroyed by the products of change of matter, partly be impaired in its vegetative energy, and consequently more and more slowly extend into the healthy tissue. At the commencement the victory is entirely with the microbes, gradually, however, their vigour grows weaker, and now the tissue cells and leucocytes can again successfully take up the battle for the nutritive material, which the microbes in their state of exhaustion can no longer materially alter. I made the following observation in the fluid contents of metastatically inflamed articulations which I repeatedly punctured: the first, as yet moderately clear, fluid obtained by puncture contained a large quantity of streptococci, but only few pus cells. A few days later the fluid was already changed into thin pus with few streptococci but a prevailing quantity of pus cells. Again, somewhat later there were scarcely any more streptococci to be found in the pure and already somewhat thickened pus. The pus cells, therefore, had finally conquered the whole field; the streptococci had perished in the chemical and morphological products of its own vegetative activity.

Experiments in artificial cultivation yielded another important result; they showed that microbes on the identical nutritive medium, in which in the beginning they most luxuriantly throve, gradually perished, even when the new generations had again and again been transplanted into new nutritive media of exactly the same kind. Before the complete cessation of their vegetation, the growth gradually became weaker and weaker, and more slow; the forms no longer attained their perfect development, and their elements in experimentative inoculations were ever decreasing until their virulence was entirely exhausted. It would therefore seem that these minute and most simple plants are as little capable as larger plants of more complicated structure, of growing continually with uniform vigour, but that they require rest from time to time, which is offered them in nature by the variations of temperature and of the amount of moisture in the air and the soil; they perhaps moreover require a frequent change of nutritive medium in order not to degenerate. Of the *Spirochietes*, the cause of recurrent fever, it must be concluded from all the symptoms that their vegetative life in the human blood is only of but a few days' duration, after which a state of rest sets in, which again after the lapse of a few days is followed by a new period of growth. Similar conditions may be the cause also of many other strictly typical zymotic diseases. Gardeners assert that old seed grains germinate much later than young ones under perfectly identical conditions. The like may also be the case with the resting-spores ("Zygospores") of microbes. In short, the conditions of vegetable life, of its vigorous or feeble growth (with which the virulence is essentially related), its degeneration and its decay, are so manifold and dependent on so many circumstances, that we shall still for a long time necessarily be engaged in their study. Immense as has been the progress of our knowledge of the microbes in regard to their pathogenic properties, we shall not possess an exhaustive comprehension of their nature before we have acquired further information in botanical, anatomical, and physiological directions. Then only many an obscure fact may be cleared up, which at present remains unexplained, as to the absolute and relative immunity of single genera of animals, of single varieties and single individuals.

We have now well-nigh accustomed ourselves to consider the microbes as *destructive enemies of the animal cells and their derivatives, the tissues*, and to recognise their peculiar different pathogenic effects in this direction. But, as already mentioned, a perfectly new fact has recently come to our knowledge, viz., *that the microbes may act upon the animal cells not only as destructive, but also as formative stimuli.*

Formative stimulus and *formative irritability!* These notions had first been developed by *Virchow* in his ingenious paper, "*Irritation and irritability*" ("*Reizung und Reizbarkeit*," Arch. für pathol. Anat., vol. xiv.). Our present generation cannot realise the impression which this and many similar comprehensive critical treatises of *Virchow* made at the time upon the younger generation whom he associated with his researches and who followed his lead. Now-a-days everything is over-hastened; our time suffers from an unappeasable hankering after continual new, or apparently new, facts, with the hope of a possible sensational success. No time will now-a-days be allowed to take occasional rest for reflection and reconsideration on the onward road of scientific pursuits. Where have we arrived at? What have we left behind—what lies ahead? Is it worth the while to proceed in this or that direction? Did we gain by our detailed work profitable knowledge of, and insight into, the whole? For all this one does not find time now. "*Irritation and irritability*," once the watchword, the Alpha and the Omega of a whole medical school! We cannot dispense with these notions in our investigations of organic nature. Therefore also *Virchow's* interpretation in this direction can never become obsolete; on the contrary, it still remains to the present day the basis of whatever we can or wish to designate by these terms, strange as it may seem to us to find the great reformer battling against views which for the present generation can only appear intelligible by the aid of detailed historical studies. In that, however, we best recognise the fundamental influence which *Virchow* has exerted from the standpoint of pathological anatomy over the whole conception of the processes of living organisms. *Virchow* was the first who lucidly demonstrated that not only the nerves and muscles are invested with irritability, but that irritability is likewise a property of the substance of each individual cell, and that this irritability can manifest itself by alterations of *function, nutrition*, and *formation;* the action of the stimuli can only be explained on the supposition that they transiently call forth, or permanently produce, specific chemical and physical alterations in the change of matter of living organisms. Although the limits of *functional, nutritive, and formative irritability* can as little be separated with precision as those of the *functional, nutritive, and formative stimuli*, nevertheless there is in this distinction a rich source of understanding of, and interest in, processes taking place in tissues which in their continual evolution lead to the most remarkable normal and pathological products. *Virchow*, in his afore-mentioned treatise, principally occupied himself with the *formative irritability*. We shall in the following briefly review those influences on the living organisms which have to be considered as *formative stimuli* on living tissues.

It is self-evident that formative stimuli only can take effect if the nutritive processes be at the same time increased. Increased nutrition, however, does not always result in a new formation, *i.e.*, an increase of tissue elements, and as little also increase of function. *A certain specific property must therefore be attributed to the formative stimulus.*

This will not likely be disputed as regards the alterations which take place in fully developed organisms. In *growing* organisms, however, nutrition and formation are so intimately blended that they cannot be thought of separated even for the shortest moment. *The action of the spermatoid on the ovum* appears to me as the highest exercise of power of a specific formative stimulus and of a specific formative irritability. Let us submit the processes herein involved to a summary examination. A series of Algæ of the lowest order, to which also belong the so-called "*Schizo-*" and "*Phyco-mycetes*," which are of special interest (Bacteria, Cocci, and yeast-plants), only multiply by continuous division of cells; favourable (fluid or soft) conditions of the soil suffice to keep up their intrinsic formative irritability for a considerable time, but will finally prove capable of exhaustion for vegetations produced by a certain generation in the same nutritive medium. *There nutrition and formation go entirely hand in hand;* the essential in the life of these organisms is just their multiplication; we may say of these organisms that we only can recognise their life in, and by, their multiplication.

The first phenomenon which we can bring into relation with *conjugation* is the appearance of *Zygospores* (*resting-spores*), which are even found in so low an order of Algæ as the bacteria (resting-spores have not yet been observed in cocci). In these the contents of the cell, in which up to this moment a continuous division had taken place, contract to a solid globule, which henceforth remains for some time at rest, may become completely desiccated like a seed-grain, but afterwards germinates when brought under favourable conditions of moisture and temperature, and growing more or less luxuriantly according as it subsequently finds assimilable nutritive matter (of which anon), produces a new Alga identical with that from which the spore first sprang.

A somewhat different process takes place in the *Mucorini* (to which order the *moulds* belong). In these a firm conjugation takes place between the terminal points of two filaments of the same plant, the septum between the conjugated terminal cells disappears, the contents of both cells commingle and contract to one solid encapsuled globule. This represents the *resting-spore* or *Zygospore* of these fungi, which possess the same properties as the afore-mentioned *Zygospores* which had been produced by the contents of a *single cell*.

The same is the case with the *conjugation of Swarm-spores* as it takes place in the genera of Algæ of the Pandorinæ, the Hydrodictyons, and the Ulothrichæ in the most varied modes, in which also three or four cells may combine into the formation of a *zygospore*. Whether the fusion into plasmodia of the Mycomycetes, to which also the Amœba belong, which so closely *resemble* the leucocytes and the pus cells, may be considered as a true conjugation, still remains doubtful.

We see that in these plants no *separation of sexes* yet exists, or at least is not perceptible, in order to produce a cell which already potentially includes a new plant. We, therefore, cannot say in this case that *one* of the cells which participate in the conjugation exerts on the *other* cell a formative, though for the time being merely a local formative stimulus.

Such a formative stimulus first distinctly manifests itself in the *Oogonia* and *Antheridia* (Sea-Algæ, fucus) by the formation of differently shaped elements, of which the movable, ciliated, mostly very minute cells are distinguished as *male cells* (*Spermatozoids*), and the resting, larger ones, as *female cells* (*ovule cells*).

Hereby we suppose that the spermatozoids act as a specific formative stimulus on the specific formative irritability of the ovule by the conflux of its plasma with that of the ovule cell. I purposely use the term "*specific formative stimulus*," because the fully developed unfertilised ovule cells most probably are susceptible of purely nutritive, and also of other kinds of stimuli. It is of course a mere hypothesis if we surmise that the ovule cells as well as the epithelial cells of the seminal ducts of the testis participate in the formation of tumours, especially of teratomas, in which we as little know the formative stimulative impulse as the process itself. The supposition of such a process, however, does not contradict our other views on the processes in the cellular elements as far as I am able to survey them.

A striking difference between the most highly organised plants, the giant trees of the virgin forest, and the most highly developed animals, is found in the circumstance that the impulse to formative development in the former seems to act almost without limit, and that the formative irritability in their growing parts persists, as from every young twig a young tree may be raised, whilst the growth in the most highly organised animals stops at a certain limit, and no multiplication from single parts (with the exception of the fertilised ovum), no genuine vegetative multiplication is known. If a tree always remains under the same conditions of nutrition, moisture, and climate, if it neither becomes diseased nor is in any other way injured, we might imagine that it would eternally continue to live and grow. Even if we were to saw it off above its main root, new buds would spring up between the wood and the bark, or from the roots, which again would grow into branches; branches would strike new roots, and whilst the stem and the majority of the roots of the former giant tree had barely decayed, several young saplings would have already sprung up, of which the most vigorous, the most rapidly growing, would overwhelm the others, secure for itself light and air, and after a thousand years a new giant tree would replace the old one. Thus this plant, provided that it has not been exterminated by root and branch, cannot be annihilated; it does not require organs of fructification to produce never so many generations; it persists through countless ages by its own inherent formative force. Nutrition and formation are here one and the same; the nutritive sap, the temperature, the conditions of moisture, are at the same time both nutritive and formative stimulus. The tree is (with the exception of the wood) continually growing in all its parts, ever young, ever able to reproduce from itself, without the act of fertilisation, new individuals.

If we fully take in the conception of this immense formative vegetative energy and persistency, and then compare with it the very limited measure of vegetative life, and the necessity of the connection of two sexes for the reproduction of new individuals, which is always more or less liable to the casualties of contact; and if we consider the rapidity with which the growth may be arrested in the most highly organised animals, then the formation of animals will no longer appear as the result of the highest, but rather of an already diminished generative force.

After having recognised persistent growth, unimpeded formation, as the most important manifestation of life, as the essential condition of life in the most highly organised plants, the question will arise. What causes, *e.g.*, man's growth to stop at a certain limit? Why has only one period of growth been allotted to him? We had to become familiar with the mystery of growth; we likewise have to accept the mystery of arrest of growth. These phenomena, just because they are mysteries to us, still lie beyond the compass of the natural sciences. Their nature is so inscrutable for our as yet insufficient methods of investigation that they fail to extend our knowledge.*

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* The experiments hitherto made with a view to explain or to understand the cessation of growth caused by mechanical conditions have but very little satisfied me. *Professor Thiersch* was the first who, in the province of histology, pointed out, albeit in a most guarded and modest manner, that the connective tissue atrophies in advanced age (his examinations started from the facial integument of old men), and becomes flaccid from this cause, and that, in consequence, its epithelial elements, especially also the glands and hair follicles, released from the pressure of the tense connective tissue, may readily lend themselves to extravagant new formations. This logically leads to the idea that at the termination of growth epithelial and connective tissue elements are brought into that opposite state of pressure which is necessary for the persistent normal function of these tissues. Reality, however, does not confirm this hypothesis, *e.g.*, the observation of those distressing cases in which the most terrible epithelial carcinomas develop in the rectum of still young, strong men. If the impulse of growth, by which nucleus diverges from nucleus and cell from cell, actually be latent in the developed tissue, viz., in some manner be converted into expansive force, this is not likely to be dependent on the mutual pressure of the tissues, as even under the pressure of so dense a membrane as, for instance, the tunica albuginea of the testicle, occasionally from quite unknown causes, and not rarely after a contusion, an immense luxuriant mass of sarcoma may develop. The pressure of such tissues on each other is not able to arrest either the growth or the pressure from secretions, *e.g.*, of a cyst; how could otherwise so many thick-walled continuous ovarian cysts form? The other hypothesis, that in each cell and in each congeries of cells the continuance of the change of matter occurs only for a certain period, and thereby the capability of multiplicating is limited, or in other words, also that the formative functions of the cells are exhaustible, is merely a periphrase, but not an explanation, of observed facts, as has already previously been mentioned concerning the microbes. It is as if we were to say that a "Fate" also rules over these phenomena; it is the standpoint of resignation on which we may, perhaps, for the present rest, without letting ourselves be deterred from further investigations and combinations of our sensory observations by *Dubois'* anathema, "*Ignorabimus!*" It may perhaps be a comfort to some that even this fate, which dominates the duration and termination of our growth, may occasionally be outwitted, by what power we, of course, do not know; but if we have set up a good Ormuzd, a wicked Ahriman will not fail to turn up too. There is in the anatomico-pathological museum at Vienna a well-formed skeleton in which *all* the epiphysial cartilages are persistent, and which, from the size and slenderness of the bones, might be supposed to be that of an individual of about twelve years of age. But it actually belonged to a dwarf who earned his living as a pedlar in Vienna, and who died in his thirty-ninth year. Nothing is known about the size of his parents. We meet in this case with the continuance of the juvenile stage. We shall not be able to understand

We now arrive at the phenomena, which, in the fully developed organism, we may accept as the results of the action of formative stimuli.

One of the most powerful stimuli we know of, and the most certain in its action, besides fecundation, is *the solution of continuity of tissues* (from which we except the fluid tissues, as blood, lymph, and pus, in which solution of continuity, strictly speaking, cannot take place.)

Whether the tissues be separated from the outside at the same time with the skin, or whether their continuity be anyhow subcutaneously interfered with, the remarkable process will always take place, that at the edges of the point of separation they will, by the division of the nuclei and the cells of their specific tissue elements, enter in some measure into a *fœtal* condition in a certain, though mostly only limited extent, and that a new period of growth will set in, which as a rule is limited to only a few days.[*]

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or to explain, either by mechanical or other kinds of processes, why in this instance the growth had been suddenly arrested, and why the epiphysial cartilages did not become ossified as pre-ordained by fate.

No more significance than the calling up of "Fate" is the familiar comparison of the building up of the organism by cells with the building up of a house; the latter pre-supposes a builder who carries out a certain plan. But as we know absolutely nothing of such a builder and a plan in the construction of an organism which, according to the comparison, ought also some time to reach a certain finish; and as modern physiology, on the contrary, maintains that every individual particle of protoplasm constitutes at the same time both builder and building material, so this comparison likewise proves lame, and fails to advance us any further.

Finding the greatest enjoyment in the intellectual play with ideas which we derive from our observations of nature, I could not refrain from writing and publishing this little essay in order to relieve my mind at last of these thoughts. In doing so, I, of course, have the feeling that such kind of reflections offer to ourselves, and perhaps also to others, more subjective artistic pleasure than that they objectively advance us in science, and that our imagination is more engaged in it than our intelligence. But where lies the boundary line? Often already have I put to myself the question, without, however, ever having succeeded in solving it, whether in the composition of the ninth Symphony Beethoven's imagination, sentiment, or intellect, had been the most active. I believe that these our reflections likewise spring from a source which had already existed as a unity before the division of our Psyche into the germinal layers of the intelligence, the sentiment, and the imagination.

[*] *Rabl*, in a discussion on his paper "*On the principles of histology*" ("*Ueber die Principien der Histologie*," Verhandlungen der anatomischen Gesellschaft, 1889, p. 62), protests against the use of the term "*fœtal*" and its interpretation. He says, "Cells are elementary organisms, and being such, they are subjected to the same laws as organisms of a higher order, persons, and their parts. Just as little as a higher organism may become degenerated ever so much, and again return to its

If we succeed in excluding every other kind of stimulus, especially all kinds of microbes, this growth in contiguous wound-surfaces will continue for about six to eight days, by which time the softened edges of the wound will in some measure have become blended; the fœtal growth with its rich formation of cells now ceases, the fœtal connective tissue becomes converted into cicatricial connective tissue, and the luxuriation of muscular cells and nerve and vascular cells altogether stops. If the different tissues are placed into accurate juxtaposition, the muscles will unite with muscular tissue, nerves with nerve tissue, and vessels with their orifices, and after the lapse of some time it will be scarcely possible to discover the cicatrice.

As in the fœtus, so also here, everything is in the beginning formed in excess, especially in the primitive vascularisation. In like manner, as the whole fœtal capillary network of the vitreous body disappears, so also in the cicatrix the numerous vessels, which will no longer be necessary for the subsequent nutrition of the tissue with its regular circulation of fluids, will disappear; the cicatrix, which in the beginning had been thick and red,

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embryonic condition, so likewise an already developed tissue can never again recover its former embryonic state." This seems to me a battle with the windmills. Surely nobody would ever have thought of understanding the term "*embryonic*" employed in pathologic histology in such a sense that the cells, which for the purpose of regeneration of tissues are produced from elements of the latter, are equivalent, let us say, to the segmentation spheres of the ovum. The terms "*embryonic*" or "*fœtal*" are here only intended to express, that a tissue which had already arrived at its termination of growth, may again return to a growing, *i.e.*, juvenile state. We use here the term "*return*" ("zurückkehren") because we suppose in most of the animal tissues, at the same time with the termination of growth, a finished boundary state beyond which there is no further advance; *Rabl* himself also speaks of "*fully developed tissues*" ("*ausgebildeten Geweben*"). Our interpretation of these processes of tissue regeneration in man (entirely leaving out of the question the inflammatory process) is shortly as follows: man is composed of a number of tissues which entirely consist of cells and of fluid, as the epithelia, the blood, and the lymph. Epithelial strata composed of several layers not even in old people attain in the deepest layers a fully developed state, they continue to form and grow as long as the organism lives. Of the process of multiplication and regeneration of the red blood corpuscles in fully developed organisms we know almost nothing. Of the lymph cells we merely suppose that they may be produced by division or budding from the elements of the lymphatic glands, the spleen and the medulla of the bones. We know of the corneal epithelium, that defects are not replaced from the depth, not from the corneal elements, but by lateral sprouting of the epithelial cells which surround the defect; I must however waive the question whether an alteration takes place in the cellular substance itself, or whether the corneal epithelium never is "*fully developed*," but perhaps is equivalent to the cells of the Rete Malpighii. As regards the simple fibrous tissue, with which I becomes thin and pale. The whole process has definitely terminated, it has attained its permanent state. Why so? That we know as little as we know why, in general, growth ceases or commences. We must here again fall back upon the idea of "*hereditary tendency*," which means about as much and as little as "Kismet."

We know several causes *which are able to increase the formative irritability after injury.*

In the first place, *foreign bodies, e.g., coagulated blood*, between the edges of the wound or between the separated tissues in general. The serum which during coagulation had been pressed out, is absorbed, and the clots only temporarily remain. We already have discarded as erroneous the former view that coagulated blood may be converted into living tissue. On the contrary, it acts as a formative stimulus, the surrounding tissues having reverted to a fœtal condition, grow into the coagulum, act upon it, liquefy it and take its place, whilst behind it permanent tissue

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class the connective tissue, the muscles, and the nerves, we in general suppose that they, provided there be no special formative stimuli in action, are "*fully developed*" as soon as the growth of the whole organism ceases. At this moment all the granular protoplasm around the nuclei, barring some most minute remains, will have been converted into fibrous tissue. This we consider to be the final state decreed by Fate in the individual animal body in which it henceforth will persist for a longer or shorter term. If we now observe, *e.g.*, in divided muscular fibre, that *Karyokinesis*,* commences in the stump, that at the same time granular protoplasm forms round the new nuclei, and that this process continues for several days, so that the end of the stump of muscular fibres now entirely consists of nuclei and granular protoplasm, if we moreover observe how this protoplasm separates and attaches itself to the individual nuclei and is converted into striped muscular fibrillæ, and how the muscular fibres now somehow grow out of the sarcolemma of the old one, then we call this process "*rejuvenescence*" ("*Jungwerden*") of the muscular tissue, the amputated fibres and fibrillæ of which could not at once grow out, but at, and between these, new granular protoplasm had first to be formed, so that the new muscular fibres were produced in the same manner as we had observed in their development in the embryo. It is not my intention to enter here more fully into processes of regeneration which take place in a gradually more complicated manner in other kinds of tissue, in which, in essentials, the same processes are observed. Let us therefore retain the term and the interpretation of "Return to the embryonic state" ("Embryonalwerden") of tissues in the regenerative processes, until these observations have been proved erroneous or the interpretation of these observations as absurd.

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* *Note by the Translator.—Karyokinesis* (καρυον "walnut," also nucleus, κινεω "I move") is the process of division of cells (in the tissue cell) as far as it passes through a series of certain successive alterations strictly according to the law, in the interior of the nucleus, whereby the latter find expression in the different arrangements of the formed constituents of the nucleus (nucleus corpuscles) and retiform framework of the nucleus.

is already forming. Muscles and nerves probably are soon arrested in their growth, but the young connective tissue with its vessels (granulation tissue) sprouts into the blood coagulum, and only stops after it has grown from both sides into one another.

In the meanwhile all the coagulum will have become liquefied and, with the exception of a few remains of pigment, will have become absorbed. The young (inflammatory) new formation, the granulation tissue, will now at last also come to rest, and pass into the permanent state of a cicatrix. In this manner, in a roundabout way, and of course with loss of time, the same result has been attained as if no foreign body had ever been interposed between the surfaces of the wound. This process, however, may be frustrated by the amount of the extravasation, or by the defective formative activity of the insinuating young tissue. The vegetative energy of the granulation tissue may sooner or later become exhausted, long before it has grown into the blood coagulum. The granulation tissue is arrested in its formation, it is converted into very vascular cicatricial tissue, and now yields also a small quantity of transudation, by which the coagulum is again rendered richer in fluids (if perhaps complete coagulation had not already taken place from the beginning). In this manner is achieved the *incapsulation of the extravasated blood*, which, like other kinds of longer standing exudations and secretions, becomes more and more rich in albumen or mucin, to such a degree that altogether it can no longer, or only very slowly, be absorbed. Thus we now have a "*Hæmatoma*," an "*incapsulated blood cyst*," before us.

If a *non-absorbable foreign body* (glass, porcelain, iron, lead, wood, &c.) is embedded in the tissue, it acts in the first line by solution of continuity as a formative stimulus. Let us suppose the most favourable case, viz., that the foreign body is perfectly free from pus cocci, moreover, that it has not carried with itself into the tissue such cocci during its entrance, then its formative stimulus will be but very slight, and will in most cases soon entirely cease. The fœtal connective and vascular tissues which have developed around it very soon will be arrested in their growth, and will be converted into cicatricial tissue. *The foreign body will be incapsulated.* According to *Professor F. A. Salzer's* investigations, the following modifications will now take place. The foreign body by its own weight presses upon the tissue, it gravitates (iron, lead), and thereby continually, but very slowly, causes new slight solutions of continuity, which again will call forth new slight formative stimuli; behind it the tissue closes with the most minute formation of cicatrix, whilst before it new young tissue, though in the most minute quantity, continues to form. The mechanical irritation also by sharp-pointed edges (glass) comes into consideration; by these longer and more intensive formative stimuli are kept up; the capsules which form around such bodies become thick and callous, their inner surface becomes permanently organised and commences to exude serum into the interior; thus a cyst forms around the foreign body. The formation of new bursæ mucosæ under callosities, which have been considered as *effects of pressure*, may likewise be explained as the effect of frequently repeated minute interruptions of continuity of tissue, as the single effects of pressure may be imagined to be divided. Or we might likewise regard as formative stimuli the continuous effects of pressure which do not materially disturb the tissue and the circulation. That would also represent a new cause of formative stimulus, against which no objection could well be raised.

We cannot dismiss the problem of the formative stimulus produced by the presence of foreign bodies without mentioning a phenomenon in which this stimulus probably acts with its highest power, namely, *the effect of a large sequestrum enclosed within an osseous capsule* on the continuously increasing, though not unlimited, thickening of this osseous capsule, as long as the sequestrum remains in it. Circumscribed accumulations of pus in the medulla, and large yellow tubercles, may likewise call forth a formative stimulus on the cambium layer at the surface of the bone. Such a stimulus may occasionally also produce extensive stalactite-like formations of osteophytes in tuberculous articular epiphyses. But such new formations of bone will not under any other circumstances take place with the same regularity as around the sequestrum. That this really is pre-eminently a mechanical stimulus—the chemical stimulus in this case is probably of minor importance—that it is brought on by the dead bone is evident from the fact that *after the removal of the sequestrum all further thickening of the bony shell ceases*, and that after the extraction of the sequestrum the filling up of the remaining empty cavity as a rule takes place very slowly, and that very soon after sequestrotomy a partial absorption of the newly formed bony masses at the same time with sclerosis of the remaining parts generally follows. I observed a necrosis caused by acute osteomyelitis of the whole tibial diaphysis accompanied by purulent softening of both epiphysial cartilages. The sequestrum naturally very soon being loosened, I extracted it in order to diminish the suppuration. In this case only the somewhat thickened periosteum was but slightly ossified, and this very inconsiderable formation of bone also disappeared after the removal of the sequestrum, and there remained an incurable pseudo-arthrosis, owing to the small amount of bone formed from the remaining articular end where no ossification whatever took place at the greater portion of the diaphysis.

I now have to treat of *the conditions under which a formative stimulus manifests itself at a defective cutaneous surface.* The results from the loss of skin by lacerations, charring, freezing, excision, &c., are that the granulation tissue is exposed on the surface without any chance of ever uniting with the opposite tissue. In what manner is this loss of substance to be replaced, and permanent cicatricial tissue formed? What becomes of the tissue after the formative stimulus of the solution of continuity has ceased to act? Every surgeon knows that this process is terminated by the formation of an investment of epidermis which, commencing at the periphery of the loss of substance, gradually continues over the granulating surface. Already the earlier observations on the healing process of superficial wounds under a scab have shown that the formation of granulations under the scab is very restricted; that under particular circumstances the formation of epidermis continues also under the scab, and that after the casting off of the latter a complete cicatrix appears. Similar processes have in recent times likewise been observed in extensive losses of substance, and have been obtained by the exclusion of vegetations of pus-cocci, *i.e.*, by a perfectly successful antiseptic treatment.

If we, however, combine the older and the more recent observations, we still find that under certain circumstances the granulation tissue will develop with peculiar luxuriance; in other words, that the formative stimulus of the solution of continuity sometimes persists. We know that the conversion of granulations into cicatricial connective tissue only takes place in a regular manner if the granulating surface is established upon moveable and contractile tissues. The condensation of granulation tissue, which to a certain extent also brings on contraction and eventually obliteration of the immoderately developed vessels, favours the development of epidermis upon the granulating surfaces. We may therefore say that the incapability of contraction of the granulating base (bone and fascia) acts in some manner as a passive formative stimulus influencing the luxuriance of the development of the granulations by preventing them from undergoing their natural fate of transformation into cicatricial tissue. Practical surgery has long ago recognised this fact, and has devised a series of methods in order to further under these circumstances the condensation of the granulations.

The profuse secretion of pus (though frequently merely a kind of mucous discharge) in these granulations when becoming fungous, being certainly dependent on the settling of pus or blennorrhœal cocci in these granulations, we might perhaps attribute to them, as promoters of the pus secretion, a certain degree of formative irritation. I merely mention this in relation to later experiences according to which some kinds of bacteria (tubercle bacilli) bring about at the same time formative irritation of the fixed tissue-elements, emigration of leucocytes, vascularisation, and formation of granulation tissue.*

Finally, we should not omit to mention that we are acquainted with certain *medicinal substances* which must undoubtedly be considered as formative stimuli. While it is generally admitted that the leucocytes, much as they have been experimented with and discussed, are not able to produce granulation and connective tissue, we must suppose that the granulation tissue with its vessels can only be the product of fixed tissue elements, though direct observations in this respect have not come to my knowledge. Granulation tissue surely is always the result of formative stimulus, and genuine tissue formations always proceed only from fixed tissue elements. I am inclined to maintain, *a priori*, that the principal elements of granulation tissue are the product of the cells of the vascular walls. The older surgeons employed a number of remedies in order to further the formation of granulations. Warmth and moisture in the form of poultices and continuous warm local baths, turpentine ointment, tartar emetic ointment, nitrate of silver ointment, savin ointment, &c., enjoyed a well-founded reputation as stimulants for the formation of granulations. We know of jodoform, that its continuous application calls forth a particular vascular granulation, even in excess. Glycerine behaves in a similar manner, and especially increases to the utmost the dilatation of the vessels. Solutions of carbolic acid act as a lasting formative stimulus, producing thick vascular cheloid cicatrices. Similar effects are known in the cases of cicatrices from cauterisation with sulphuric or nitric acid, of the cicatrices of burns by flame, &c.

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* We cannot deny that from the present standpoint of our knowledge, a precise distinction between purely phlogogenic, pyogenic, and formative stimuli, and consequently also an absolute distinction between inflammation, suppuration, and regeneration, is barely feasible without straining the observed facts. All these three processes may certainly almost exist entirely each by itself, but their combination is by far the more frequent occurrence, although with a prominence of one or the other. On this subject I have come to the following conclusions: (1) We must regard the softening of tissues (especially of the walls of the blood-vessels) in inflammation as a kind of peptonisation, as the immediate effect of the growth of phlogogenic microbes. This effect may be very slight and transient, so that the tissue elements, without having undergone a formative alteration, very soon return to their normal physiological condition; the walls of the vessels permit the emigration of a number of leucocytes which re-immigrate into the vessels and return to their normal state. (2) The stimulus acts longer and more slowly; it also involves the fixed tissue elements, especially the cells of the connective tissue and the vessels, it acts formatively upon these; at the same time emigration of leucocytes in moderate number takes place, perhaps here and there also a fibrinous exudation forms. These processes may occur in subacute and chronic inflammations, and they may terminate in hypertrophic thickening, which again may completely disappear. (3) The phlogogenic

It has been proved, by similar observations, that the formative irritation therefore can likewise be increased by chemicals, as has already been shown by former observations, that it can be called forth by mechanical means.

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ptomaine sooner or later kills the tissue with or without coagulation. Thereby loss of substance is brought about, a solution of continuity which by itself acts as a formative stimulus and leads to cicatrisation—to regeneration.

It seems to me, however, barely theoretically feasible to regard this latter case as the only possible one, and to deny every kind of formative stimulant effect to the chemical products of growth from the staphylo- and strepto-coccus, &c., particularly in consideration of the fact, that also in the majority of blennorrhœas the vessels are not only mechanically enlarged, but also become in many ways tortuous and twisted, the latter always being the consequence of a longitudinal growth of the vessels; and real growth cannot altogether be imagined without a numerical increase of tissue element, because the mere enlargement alone of the elements could not cause the formation of so many windings and meanderings of the vessels in the inflamed tissue. I can only fully agree with *Baumgarten*, when he states: "We shall now be obliged to admit an *inflammatory proliferation* of the fixed tissue cells, beside the *regenerative* and *purely hyperplastic* (tumour-forming) one."

Some of my readers may perhaps have been surprised that I had not long before alluded to the *accumulation and engorgement of nutritive fluid* in certain regions of the body as *formative stimuli*. I believe that this cause has been much overrated. There is a general current and hackneyed opinion that the development of varicosities produces not only purely hypertrophic but also hyperplastic processes in the skin, the subcutaneous cellular tissue, and even in and on the bone. But even should the problem be solved why varices only occasionally call forth these conditions, and why sometimes not at all, I should still hesitate to attribute it to the engorgement of venous blood and of lymph alone without further inquiries for the cases of hyperplastic elephantiasis. Sporadic cases of elephantiasis of the leg as they occur in man are frequently accompanied by far slighter varicosities than in the female with the most delicate normal skin. I suppose that the aforementioned hyperplasias have the same causes as other kinds of inflammation, namely, that they are brought about by feebly formative irritant microbes, and that they therefore always represent a merely accidental combination with varicosities. We must not forget that the formation of varicosities is essentially due to an enormous untimely longitudinal growth of certain veins which surely cannot possibly take place without hyperplasia of the cells of the vascular walls. If increase of intervascular pressure (to which the main cause is mostly attributed in the etiology of varicosities) really participate in this process, the effect could only very slowly be brought about; experiments may perhaps elucidate this question. Again, heredity or "Fate" is here, according to my experience, the principal cause; the predisposition to hyperplasia of the venous walls is transmitted by the act of impregnation; it also takes place without any accidental causes. Not long ago I saw in consultation a strong young man of about twenty years of age, whose leg was completely covered with thick varicosities but without thickening of the skin. All my inquiries after accidental causes failed. His mother, when still quite a young woman, had already become affected with varicosities.

It has not yet been ascertained whether *increased function* may also be considered as one of the formative stimuli. The majority of those who have investigated this subject, especially *Nothnagel* in his instructive treatise, "*On adaptations and com-*

pensations in pathological processes" (*"Ueber Anpassungen und Ausgleichungen bei pathologischen Zuständen"*), favour the supposition that increased function principally acts as a *"nutritive"* stimulus, *i.e.*, that the increase in mass, with the increased action of muscles and glands, is principally brought about by enlargement of the functional tissue elements (hypertrophy), but scarcely traceable to multiplication of these (hyperplasia). To this the arteries of medium size apparently are an exception, which immensely thicken and elongate for the establishment of the collateral circulation, This interstitial hyperplasia of the walls of the vessels, however, is not the immediate consequence of the increased muscular action above the ligature, it does not occur even in the ligatured arteries above the ligature, and therefore could not be compared with the hypertrophy of the left ventricle in consequence of stenosis of the aorta. On the contrary, it occurs in those arteries which, branching off above the ligature, establish the collateral circulation. I am unable to decide whether *Nothnagel's* hypothesis be correct, that *the increased velocity of the blood current* in these small arteries, which are devoid of vasa vasorum, causes the nutrition, and thereby the hypertrophy and hyperplasia, of the elements of the vascular walls. At any rate, it does not conform with this view if we consider *the lessened velocity of the current* and the increased pressure in the veins as formative stimulus as the cause of the development of varicosities, a view which, as I have already stated, I do not share, though I am unable to substitute for it a more feasible explanation.*

I shall now treat of the formative stimuli which are called forth by a *growing vegetable cell* upon the cells of the animal organism. I have no personal experience on *Lepra*, but *Mickulicz's* researches on *Rhinoscleroma* had been carried out under my eyes at a time when the bacterial etiology which had been propounded by *von Frisch* at a much later period had not even been thought of.

A kind of firm granulation tissue is produced, of which we at present know that it must have emanated from the fixed elements of the connective tissue by formation of cells of epithelial (or more accurately, perhaps, of endothelial) character. The new connective tissue which is enclosed within the old, is, in contrast to the genuine granulation tissue, but very scantily vascularised; it soon changes into firm cicatricial cheloid tissue, which becomes more and more dense, and finally may even ossify. Suppuration is only brought about in it by accidental causes acting from without. Knowing at present that the whole process has been called forth by bacilli, we must say that the bacilli act in the first line as a formative stimulus on the fixed cells of the connective tissue, probably also of the muscles and nerves; but their effect as formative stimulants is but of very short duration. It scarcely comes to a disturbing emigration of leucocytes and excessive vascularisation; but the effect of the bacilli is merely formative and is soon extinguished; the transformation of a new tissue into a cicatrix takes place with relative rapidity without any kind of disturbance whatever. The process much resembles the formation of the fibrous tubercle, of which anon.

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* The latest experiments of *Ponfick* on the immense capability of regeneration of the liver after excision of even very large portions of it are of particular great interest. This process is so powerful that it probably can only be brought about by a genuine "*hyperplasia.*" It is the most considerable instance of regeneration hitherto known of in warm-blooded animals.

The action of *the tubercle bacilli* upon the cellular elements of the animal body is much more complicated. The effect of these bacilli, which grow with but moderate vegetative energy, manifests itself, according to *Baumgarten*, in this, that a more or less rapid division of the nuclei after the various types of the so-called "*Karyokinesis*" takes place in the fixed elements of the connective tissue, by which large flat cells with oval nuclei are produced, which are converted into a firm tissue granule, the *primary tubercle proper.* Thereby under certain conditions also the formation of multinucleated cells more or less frequently comes about—of the so-called "*tubercle giant cells*" with nuclei attached to the wall and central disintegration.

I shall here omit to speak of the "giant cells," which recently have been the subject of so much discussion, and of the manifold hypotheses regarding their origin, as they are not of material importance for the fundamental biological processes which now follow.

The common fate of tubercles is, as is well known, their disintegration into a dry cheesy mass. But before this process is so far advanced, dilatation of the vessels with emigration of leucocytes, and after that the formation of an envelope of lymphoid or granular tissue, takes place in their immediate neighbourhood. Herewith the central growth of the tubercle generally ceases;

its disintegration will be complete; it will be incapsulated like a foreign body by the conversion of the granulation tissue into cicatricial tissue (provided that no pus cocci intervene and change the tubercle into a tuberculous abscess or into a tuberculous ulcer).

To this I have still to add that the disintegration of the tubercle by no means always takes place. There are (though very rare) cases in which the endothelial cells—probably when the irritation set up by only a few bacilli with but feeble vegetative energy—are directly converted into firm connective tissue without previous disintegration. The "*fibrous tubercle*" formed in this manner, which especially is occasionally observed in the cervical and axillary glands, contains, as I have only recently had an opportunity of convincing myself, no detritus, and does not represent anything like a firm capsule around the disintegrated tubercles, but is throughout purely fibrous. I now feel convinced that those forms of fibrous malignant lymphoma which had been investigated in my clinic and described by *von Winiwarter*, and which are so very differently constructed from the soft malignant lymphoma which partially disappears under arsenical treatment, are a bacillary, genuine tubercle disease. These investigations ought to be repeated from this new point of view.

The question now arises, as regards the common form of the centrally disintegrated tubercle, *By what kind of stimulus is the granulation tissue produced which luxuriates around it?* We might here, in the first place, suppose that the disturbance of continuity and the gradually increasing pressure of the growing tubercle act as formative stimulants. We know that a gradual new formation of tolerably dense membrane of connective tissue takes place around a slowly growing cysticercus, around trichini, and around ecchinococcus cysts. We know that some cyst walls consist of entirely new formed membrane. We further know that the tunica vaginalis around the fluid of hydrocele frequently becomes extremely thickened by new formation of connective tissue, that moderately dense membrane develops around the fat enclosed in sebaceous glands (atheroma), and also in the formation of ranula a similar membrane forms around the retained mucus-like saliva. In all these cases both pressure and disturbance of continuity are undoubtedly, although slowly and feebly, active as formative stimulants, without, however, any particular concomitant chemical effects whatever on the enclosed fluid or pulpy contents of these cysts. The expansion of a tubercle, however, is so slight, and in comparison with the above-mentioned cases relatively of so short a duration, that other and more important features must certainly here come into play. What causes, then, the formation of granulations around the tubercle? Is it the continued direct effect of the tubercle bacilli, or is it due to the action of endothelial cells which had been primarily produced by the bacilli, and consequently an indirect bacillary effect, somehow in the second generation? *Baumgarten's* observation, that in rapidly forming miliary tubercles the number of bacilli is very great, the disintegration of the endothelial new formation is very rapid, the development of the covering lymphoid tissue is so very rapid, that the formation of an epithelial nodule may be easily, almost entirely, overlooked, support the view that the *bacilli themselves* constitute the formative stimulus also in the formation of lymphoid (granulation) tissue. They consequently would be able to produce one after the other two kinds of tissue—viz., the endothelial nodule and the granulation tissue. That the latter, according to our present views, can only be brought about by leucocytes, I already repeatedly pointed out. The apparent peculiarity of this phenomenon might perhaps be explained in that bacilli act as a formative stimulus also on the capillary cells. Some closer attention ought perhaps to be directed to the possibility of Karyokinetic forms in the nuclei of the capillaries. If such are discovered—which seems not to be improbable after the observations of giant cells, which are found in intimate connection with the walls of the vessels in *Pacchioni's granulations* (*Kolliker's Osteoblasts*)—we may suppose that the capillaries, with their adventitious cells, and especially the cells on the walls of the so-called "transition vessels," lead not only to the new formation of vessels, but in general to the development of granulation tissue, the origin of which, from leucocytes, is now no longer tenable.

The formative stimulating action of the tubercle cells according to their quantity and their vegetative energy is at any rate extremely various (we here leave entirely out of consideration the relative immunity of individual warm-blooded animals, as well as the question of the existence of individual immunity and predisposition). We may well regard the acute miliary tubercle with its rapid lymphoid transformation as the one end, and the fibrous tubercle in which scarcely an appreciable formation of lymphoid tissue takes place, as the other end of the series.

The formative stimulus of the *tubercle detritus*, of the yellow tubercle, is at any rate but very slight. We may observe, *e.g.*, that in bone an eburnified shell is formed around the tubercle, which, however, does not give rise to extensive sclerosis or extensive osteophytes over a large area except in the case of the formation of a sequestrum and the immigration of pus cocci, which then again calls forth a new formation of granulations around, and purulent softening of the tubercle, an accident which also seems again to support the view that a certain degree of formative stimulus may likewise be attributed to the pus cocci. That the tubercle bacilli themselves are able directly to stimulate the suppurative process in a material degree is very improbable, according to the observations which we have gathered up to this date, although the opportunity for the emigration of leucocytes must be facilitated by the formative stimulus on the vascular walls, and the transformation of the latter into soft protoplasm.

One point more ought here to be mentioned. A copious rapid development of a crop of tubercles leads in the majority of cases to the formation of fluid sero-fibrinous exudations. These are genuine exudations, not merely transudations, like those in the pleural and peritoneal cavities during the development of tumours, especially of carcinomas and sarcomas. Acute tuberculosis of the synovial membrane, of the pleura and the meninges, is almost always followed by exudations which cannot be distinguished from others in acute inflammations. Consequently, tubercle bacilli, when acting with exceptional vegetative energy, may call forth nutritive disturbances which seem entirely identical with inflammations acutely produced by staphylo- and strepto-cocci. At the same time also pyrogenic matters are formed, the absorption of which gives rise to fever and even general septic typhoid disease.

Though we must admit that tubercle bacilli alone will not produce all the acute phlegmonous processes, blennorrhœas, and purulent exudations, at least not primarily, still, according to the already stated facts, we know of no other kind of bacilli or cocci whose effect on the animal tissue, in one and the same species, are so multiform. The disproportion between the size of the primary tubercle and the luxuriance of granulations and the exudation produced around it, presents itself to the surgeon particularly in the so-called "*cold abscesses*" by tubercle of the bone; these originally always contain only a thin and clear, later on a turbid, sometimes slightly blood-tinged, or may be a mucus-like serum, and here and there mingled with clots; their capsule is lined by mucous granulations, in which only very rarely tubercle-granules with tubercle-bacilli are found. The latter completely disappear if the abscess burst and pus cocci immigrate, or if they, in very rare instances, find admission from the interior of the body into the wall of the abscess. This will manifest itself by increase of pain and fever. A cold abscess containing one litre (two pints) or more may result from a tubercle in bone of the size of a pea. We find, on the other hand, in dry caries, neither excessive luxuriance of granulatious, nor suppuration, nor exudation, but either firmer granulations (sometimes almost of the consistency of cartilage) which are imbedded in the lacunæ of the eroded bone, and frequently contain many giant cells, and only a few or no bacilli at all (analogous to the fibrous tubercle of the soft parts), or we find the carious focus *only* filled with, and surrounded by, yellow tubercle pulp without a trace of formation of granulations and suppuration in the neighbourhood, this pulp being merely enclosed by a moderately thick capsule. It is only by the frequent opening of abscesses and the energetic operative treatment of these cases that we acquire a larger experience of the manifoldness of these processes of which the pathological anatomist sees only the final stages.

In these observations we now have to face the question, Are these differences of effect really caused by differences of the vegetative energy, and by the number of the bacilli accidentally retained in the tissue, or, *are there different varieties of tubercle bacilli which we are not yet able to distinguish from each other? Or are there vegetative forms and stages of development of these bacilli which we have not yet succeeded in demonstrating by our present method?* We know how unsettled still are the views, whether the delicately granulated varieties occurring under certain conditions in the plasma of the tubercle bacilli have to be interpreted in this or that manner. Are they spores or are they vacuoles? And if they be spores, where do they remain? They disappear and we are no longer able to trace them; nobody has ever seen them germinating. Could they not continue to vegetate in some form of cocci, and as such call forth different kinds of stimulus on the tissue from that of the fully developed bacilli? "Chi lo sà?" ("Who knows?").

Whilst the tubercle bacilli only conditionally produce the phenomena of acute inflammations, and as such never copious suppuration, the *Glanders* bacilli act at the same time as formative stimuli and also pyogenic, upon the fixed tissue elements.

The formation of small foci of endothelial cells is speedily followed by the emigration of leucocytes in masses, and subsequently also by destruction by purulent softening of the tissue. The glanders bacilli therefore occupy, as regards their pathogenic effects, in some measure the mean between tubercle bacilli and pus cocci. Thereby they rapidly lead to purulent ulcerative processes, and, when rapidly developing and energetically vegetating, to general septo-pyæmic poisoning; again, a quite peculiar action of vegetable cells upon animal cells.

The existence of the *Syphilis bacillus* has not yet been proved beyond dispute.[*] There is some probability that it might be related to the tubercle and the glanders bacillus. The soft

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[*] *Note by the Translator.*—Passing over those agents of the syphilitic virus which had formerly been regarded as syphilis microbes, which, however, did not comply with the requirements of the present standpoint of Bacteriology, we have first to mention the bacillus discovered in 1885 by *Lustgarten* in syphilitic products, which much resembles, both in its form and in its size, the tubercle bacillus, and is characterised by specific methods of staining. *Lustgarten* dyed his sections in *Ehrlich Weigert's* solution gentian violet at the temperature of the room for twelve to twenty-four hours, and after this at a temperature of 40° C. (104° F.) in an incubator for two hours, washed them for a few minutes in absolute alcohol, and placed them for the purpose of discolouration for ten seconds in an aqueous solution of one and a half per cent. of hypermanganate of potassium, and then for about the same length of time in sulphurous acid. After washing the sections in water they are again placed for about three to four seconds into the above-mentioned discolouring fluid, and after three to four times repeating the process the ground of the preparation will be discoloured and only the bacilli will appear as violet, slightly undulated, or S-shaped curved rods. Dry cover glass preparations of syphilitic sections or tissue fluid are stained in the same manner, only that the preparations are left for a shorter time in the colouring solutions, and after staining them in the gentian violet they are not washed in alcohol, but in water.

A more simple method is that of *De Giacomi*, who stains his dry cover glass preparations for a few minutes in a hot solution of fuchsine and then in water with the addition of a few minims of a solution of perchloride of iron, and after washing them in water, discolours them in a concentrated solution of perchloride chancre shows a certain analogy with glanders, the hard chancre partly with the slowly vegetating tubercle prone to disintegration, and in its later stages to the fibrous tubercle. The luxuriation in and around the syphilomas is very variable; in bones there is a disposition to necrotic caries both in syphiloma and in tubercle. Every experienced surgeon knows how difficult it sometimes is to distinguish between Tuberculosis, Syphilis, Rhinoscleroma, and Lepra (Carcinomatosis) in their products.

It is generally agreed that the *gonorrhœa-cocci* exert no formative stimulus and produce no phlegmonous process. The

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of iron. This preparation, which shows the bacilli in red colour, may be stained a second time with any optional contrast colour.

For sections preparations *Gottstein's* modification of *Giacomi's* method will be found particularly suitable; the sections stained with fuchsine for twenty-four hours, after having washed with water and placed for a few seconds in a diluted solution of perchloride of iron, are again washed with alcohol, rendered transparent by oil of cloves or xylol, and preserved in Canada balsam. *Doutrelepont* has demonstrated the same bacilli in syphilitic tissues independently of *Lustgarten* by a different method of staining; treatment for twenty-four to forty-eight hours with an aqueous solution of gentian violet, discolouration during a few seconds in a mixture of one part of nitric acid and fifteen parts of water, and after that for five to ten minutes in sixty per cent. alcohol; second staining in an aqueous solution of saffron, washing again with sixty per cent. alcohol, discolouration in absolute alcohol, rendering transparent in oil of cedar and preservation in Canada balsam.

Controlling examinations by a number of other investigators (*Matterstock*, *Klemperer*, *Gottstein*, *Marcuse*, *Lewy*, *&c.*) proved the constant presence of these bacilli in all syphilitic secretions and in every tissue affected by syphilis, so that, supported by these confirming evidences, *Lustgarten*, *Weigert*, and *Doutrelepont* regard these bacilli as the agent of the syphilitic poison; cultures of, and inoculations with, them have however not yet succeeded. Soon afterwards nevertheless *Alvarez* and *Tavel* conjointedly, and *Matterstock* working independently, discovered a bacillus so much like the syphilis bacillus, in the præputial smegma, in the secretions of the mucous membrane of the female genitals and also at the anus of healthy people, that many investigators consider these as identical with the smegma bacillus. The syphilis bacilli, however, acording to *Lewy*, lie mostly *on* the epithelium, and only occur singly and exposed on the surface; they are but rarely observed in larger groups. The smegma bacilli, on the contrary, are found *upon*, or in *close connection with*, the epithelium. They frequently occur in larger groups, but are also found in great number *outside* the epithelium. The syphilis bacilli present mostly slender, straight, or curved rods; the smegma bacilli are smaller, plumper rods, and in general show a much greater variety of form. Whilst the syphilis bacilli resist the alcohol tolerably long, the smegma bacilli are soon discoloured by it. Acids discolour the syphilis bacilli within thirty to forty-five seconds; the smegma bacilli frequently withstand acids for two minutes and longer. The syphilis bacilli are almost immediately discoloured by glacial acetic acid, and the smegma bacilli withstand glacial acetic acid up to twenty-five seconds. The syphilis bacilli are the more numerous the younger the infiltration, the smegma bacilli, on the contrary, are the more numerous the longer the secretion had been accumulating.

fact that frequently after gonorrhœa of long standing no stricture forms, and after gonorrhœa of but short existence it does so occasionally, and in that case also suppuration around the urethra and the prostate (perineal abscesses), seems to indicate that these processes are merely accidental and caused by casual immigration of pus-cocci. But what happens in the case of *acuminate condylomas?* Their appearance in gonorrhœa is so variable that in this instance they may be regarded as accidental. Here comes a new circumstance which hitherto has not been taken into account, namely, the formative irritability of the genuine epithelia and the causes which call forth their activity. As this is immediately connected with the question, whether perhaps the formation of carcinoma may likewise be thought of as dependent on microbes, a question which I intend to enter into at the conclusion of these observations, I shall not discuss this subject here.

There is one more point which I ought not to pass over, namely, the formation of the so-called *soft flat condylomas* on the skin continually irrigated by *urine*. We observe this as well in vesico-vaginal fistula as in extroversion of the bladder. The continuous bathing of the perineal and femoral skin in fluids alone cannot account for it. We know from the time when wounds were treated by continuous irrigation or permanent baths that the cutis swelled to an enormous degree, but uniformly, yet no formation of condylomas took place. There is little probability that in the circumscribed form of these condylomas the salts of the urine, or the ammonia of the decomposed urine alone, produce these formations, although also the ammonia contained in the alkaline urine may soften the epidermis, and even the superficial capillaries of the cutis. The afore-mentioned urinary condylomas respond rather to the settling of colonies of streptococcus urinæ, which, retained in the slight unevennesses of the softened epidermis, establish themselves here and there, and bring about a moderate papillary hyperplasia with increased formation of epidermis. We therefore must consider also the streptococcus urinæ as a formative, though only slightly intensive cause of stimulation.

After having passed in review all the effects of formative irritation known to us of the different vegetable cells upon the animal tissues, I now shall consider *whether animal cells are able to act in a similar manner upon the vegetable tissue.*

It is known that there are not only saprophyti, but also specific pathogenic fungi, which attack and eventually destroy plants of complicated structure, that the *moulds* or *mildew fungi* and the more highly organised *algæ* may be again destroyed by microbes which on their part are to be classified with the saprophytic and pathogenic series. It must be left an open question whether there are processes in plants which according to their nature can be compared with the inflammatory processes in animal tissues. The condition which is called by phytopathologists "*Frost-gangrene*" ("*Frost-brand*") and "canker *of the trees*" (apple-trees and beeches) may also partly belong to this class. There is much probability in favour of the view that these processes are brought about partly by a fungus, a *Pyromycetes (Nectaria ditissima)*, partly by the apple aphis or American blight ("Blutlaus," *Schizoneura lanigera Hausm.*).

We shall now only occupy ourselves with observations on *the formative irritability of vegetable cells.* My previous remarks on copulation and fertilisation as formative stimuli, having already referred to vegetable cells, need therefore no repetition.

In the plants also *separation of continuity* acts as a powerful formative stimulus. It is followed by new formation of tissue, cicatrization, formation of callus ("Überwallung") with or without necrosis, and eventually leads to the union of two opposite wound-surfaces. The improvement in the quality of fruit-trees, of roses, &c., by budding or grafting is brought about by this process. The tissue of the so-called "callus" ("Überwallung") as it forms, *e.g.*, after the lopping of the branches, is the so-called "*corky layer*" ("*Periderma*") which proceeds from the parenchyma of the bark, of the cambium, and of the pith, and might be compared with the granulation tissue in animals.

The formative stimulus of the separation of continuity in plants, is, under certain circumstances, particularly increased. New plant individuals can be raised from parts of plants; multiplication by layering, cuttings, or slips. When a boy, I watched with the keenest interest a cutting of a damask rose placed in a phial of water in which the lower border of the section gradually thickened and finally put forth delicate white adventitious roots (radicles). Moreover, in many plants a new plant may be produced from each portion of a branch, and at the superior portion of the branch sometimes even new, so-called "*adventitious bud-spores*" are formed. The leaves of many *Gesneriaceæ* produce, at the place where the petiole has been fractured or notched, new buds, which may become starting points of new leaves and branches. Therefore a pathological stimulus is followed by the formation of new physiological organs. (This reminds one of the "*post-regeneration*" in injured frog eggs, described by *W. Roux.*) We shall not, probably, for a long time succeed in tracing the *causes of these processes*, even if we were able to analyse the morphological process itself much more accurately with improved microscopes than we have already been able to do.

In general we may suppose that the effects of formative irritation also in more highly organised plants are much more effective in every direction than in animals.

As, according to the observations at our disposal, divided vegetable cells always perish, and only the next following uninjured cells come into formative activity, we might surmise that the products of decomposition forming during the decay of the injured cells act as chemical irritants upon the nearest cells. All these, however, are but infinitesimal agents in processes of such magnitude in their essence and effects.

What is of particular interest to us is the observation that a large series of excessive tissue formation in plants or buds, leaves, stalks, and roots, the so-called "*galls*" or "*cecidia*" are called forth by stimuli which undoubtedly are caused by animal cells.*

I shall only briefly mention the existence of the *mycocecidia*, *i.e.*, *galls*, which are exclusively produced by the luxuriant growth of fungi. To these belong the "*Wood-knot*" ("*Holzkropf*") of the trembling poplar or aspen ("*Populus tremula*") on the stem and branches of which knobs of the size of a filbert to that of a pigeon's egg are formed by the luxuriant growth of certain fungi ("*Pyrenomycetes*"), the turgescences of the roots of *Papilionaceæ* and of the alder by a fungus as yet little known ("*Schinzia leguminosarum*"), &c. Of great morphological interest are likewise the microscopical galls which are produced on some algæ by *Chytridiaceæ*, especially of the genus *Synchi-*

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* I am principally indebted for my information on these most remarkable formations to the excellent work of *A. B. Frank*, "*Diseases of Plants*" ("Die Krankheiten der Pflanzen." Breslau, 1880.)

trium. The swarm spores of these fungi bore into the epidermis of the algæ, and after the development from them of a *sorus*, *i.e.*, a small round cluster of cells with the character of *Sporangia*, the latter is incapsulated by a luxuriant growth of epidermis cells. (A quite identical process is brought about in algæ of the genus *Vaucheria* by *Rotatoria* and their brood.) The number of these genera of the *Mycocecidia* is, on the whole, however, very small in comparison with the extremely rich variety of forms of galls produced by animals.

The most manifold and peculiar forms of galls are caused by *Mites*, *Phytoptus* (*Acaro-* or *Phytopto-cecidia*). They produce the *pathological formation of hair* on the surface of leaves ("*Erineum formation*" on walnut, vine, lime, oak, beech, apple, birch, and poplar leaves, &c., and on many herbs), the *pocket* or *bladder galls* (on linden, plum, maple, elm, willow, and beech leaves, &c.), the peculiar *leaf rolls and folding and crimping of leaves with thickening of the leaf itself* (of the linden, beech, willow, rose, virgin's bower, or clematis, &c.), the *swelling of buds and deformation of the apices of the buds*, the *spangle galls* ("*Pockenkrankheit*") *of the leaves* (of the pear, apple, walnut, and elm), and on the back of the oak leaves.*

Many kinds of *Hemiptera* produce galls, of which those caused by the *plant lice* or *Aphidæ* (*Aphidiocecidia*) are the most numerous. Their forms are similar to those of the former class, and are again distinguished as leaf rolls, pocket galls, deformations of the apices of the buds (*pineapple* or *spruce galls*). There are, moreover, *root galls*, as those produced, *e.g.*, on the vine roots by *Phylloxera vastatrix* (kind of *aphis*).

A large series of most curious forms of galls are produced by *the larvæ of flies and wasps*, but only in rare cases also by those of *butterflies*, *moths*, and *beetles*. Also in this series all the afore-named types are represented, some of particularly luxuriant and interesting form, among which we class also the turgescences of the stalk, the *stalk galls* ("*Stengelgallen*"), *e.g.*, the *Cecidomyca salicis* on the *goat willow* (*Salix capra*) and the *Lascoptera rubi* on the *bramble*.

The best known are the *galls on the oak leaves*, the so-called "*Oak apples*" (again of the most manifold form, *e.g.*, the *Arti-*

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* *Note by the Translator*.—The latter kind of spangle galls are also caused by the *Neuroterus lenticularis*, a kind of gall wasp (Cynips).

choke galls on the *Quercus pedunculata*, a variety of the *English oak, Quercus robus*), and the *Mossy galls*, also called "*Rose Bedeguars*" or "*Robin Redbreast's pincushion*," the first of which (the oak galls) are produced by several kinds of wasp (mostly by some species of *Cynips*), the latter (the mossy galls) resembling bundles of moss, frequently of most luxuriant and showy formation, are caused by the *Rhodites rosarum* which infests the *Rosa spinosissima* and *Eglanteria*.

There is a particular charm to be found in the study of the manifoldness of these formations and of the process of their development. They offer so interesting a parallel with the formation of genuine tumours in animals, that we might well be induced to arrange them into similar groups as tumours according to their form. There would be no difficulty in arranging groups, as for example, Papilloma, Polypus, Fibroma, Sarcoma, Osteoma, &c. I have already mentioned that carcinomatous ulcerations and luxuriations in plants are also spoken of.

We are here only interested in learning whether particulars are known of the mode of development of these gall formations, as there is no longer any doubt about their cause and their growth in general.

The one fact we can accept as certain, is that the slight mechanical injury caused by the insects in the deposition of their eggs into, or upon, the surface of a plant, can never be alone the cause of gall formation, however high we may value the separation of continuity as a formative stimulus in plants. Even the hypertrophical cicatricial callus ("Narbenüberwallung"), as it especially occurs after lesions of the bark, have neither in structure nor in form any resemblance to galls. They are always in proportion in shape and depth to the injury, as we know from letters cut in the stems of young trees in which the deeply incised parts are replaced by wheals formed of minute warts. Here the forces of regeneration and growth combine in order to produce a new formation pathological both in form and structure. The comparison with cheloid cicatrices readily suggests itself, though also in the latter the fatalistic formation of growths does not enter into the question.

Already the fact that only certain kinds of animals produce galls of specific forms on certain kinds of plants is an indication that here quite particular conditions come into action. It may perhaps be unphilosophical to presume upon an immunity of certain plants against the action of certain gall-producers. Why does the butterfly, again, after having strayed far, far from its native place, deposit its eggs only on certain plants? Because its fate, or its hereditary memory, or something unconscious within it, tells it that the caterpillars after having escaped from the eggs can only live on the leaves of certain plants. Whether the *Rhodites* species which produce the elegant moss-galls on roses may not bring about the identical forms on other plants we do not yet know, because this species of wasp never lay their eggs on any other kind of plant. Their larvæ, after escaping from the egg, thrive best, or only, on the marrow substance of the rose-galls.

We cannot well dispense with the teleological speculation for the understanding of most of these processes in the vegetable and animal world without depriving ourselves of a great enjoyment in our investigations. I by no means consider as injurious the teleological speculations on nature which have been for some time so much condemned, provided we always bear in mind that processes like the afore-described are as much necessary effects of the material forces as all the conscious and unconscious acts of volition in general.

If the wasp, therefore, be obliged to deposit its eggs upon, or into, an oak leaf, a shell will form from the latter (like the egg shell around a bird's egg), which protects them and its contents, and at the same time serves as nourishment for the young maggots. If the same wasp were to lay its eggs, *e.g.*, in the leaf of a horse-chestnut, perhaps also a gall would form, but the hatched maggots would probably die, poisoned from feeding on this gall, or they would probably be unable to assimilate this unsuitable kind of food, and consequently would starve. The undoubtedly specific character in many ways of the formation of galls will not justify the supposition of immunity in any kind of plant, of the absence of a formative irritability against the stimulus proceeding from an animal. Such an immunity may, however, exist, and it would certainly be of great interest to institute experimental studies on this subject.

If, then, after what we have said, we cannot consider the mechanical stimulus of injuries (the existence of an injury moreover is by no means ascertained in many gall formations) as the cause of these gall formations, a second alleged cause seems to me likewise of but doubtful importance. It is asserted by many that *the gall formation is caused, and especially its enlargement is brought about, by the suction of the sap, by mites, lice, and larvæ (maggots).* Irrespectively of the fact that galls frequently are already developing before the animals have escaped from their eggs, and of the fact that, *e.g.*, perfectly abnormal gall-hair formations of leaves which are entirely different from the normal hairs of the leaves, may not possibly be produced by the suction of the plant-juice, also in this supposition the production of specifically organised new formations as the galls, remained absolutely unexplained. If there occur, *e.g.*, in the lime leaves, according to the action of different kinds of mites, either hair-formations, or pocket-galls, or leaf-rolls, and if we are informed that, *e.g.*, of certain kinds of *Coccidæ* (*Brachyscelis pileata*, *ovicula*, and *duplex*) on the *Eucalyptus* species in Australia, the males form tubular or trumpet-shaped galls with an opening at the apex, the females on the contrary produce thick utricular galls closing with a lid, we can scarcely understand that this is brought about by suction of the juices alone, if at all.

If, once more, we inquire into the said mechanical causes, we may have to admit that certain excesses of supply ("*Überschwemmung*") of nutritive material have to be considered of more importance as a cause of irritation for the production of hyperplasia in vegetable than in animal cells, and that the vegetable cell in general possesses a greater hereditary disposition for it. Still we ought to suppose that in this case at the most only a hypertrophic and hyperplastic process analogous to the formation of callus could be brought about which ought to show the type common to all the new formations which form after injuries in plants. We may imagine the suction-apparatus with its bite never so different, the suction-movement in its intensity and rhythm never so varied, still we could not always understand why so many different forms of galls are thus produced. I will only briefly mention that the suction-action does not all come into consideration in the formation of *Mycocecidia*.*

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* By the suction of the *apple aphis* or *American blight* ("*Blutlaus*," *Schizoneura lanigera*) conditions may be produced which are known by the name of *canker of the apple-tree;* from this formation, however, to the organisation of complicated galls there is a long step.

After what we have said, the reader will not feel surprised at my expressing the opinion that I consider *the action of the insects which produce galls to be perfectly specific, and moreover chemically specific*, although at present it cannot yet be quite appreciated. The investigations by botanists on the primary processes in the formation of galls and the immediate causes of these, are of but recent date and still far from being conclusive. *A. B. Frank*, who occupied himself very much with this subject, gives us some hints in this direction. He says in a summary on the gall-formation: "The causes are, first, *the still developing state of the part of the plant;* and, secondly, *the action of the parasites.* We only know the manifestation of the phenomenon; the nature of the gall-forming stimulus still remains veiled."

We find in the youngest *Acarocecidia* that there frequently are no mites within, but that they are occupied by them only at a later period. This observation suggests the probability that the mites scarify these leaves, and at the same time introduce into them a substance which in the manner of a ferment exerts the continuous action of a formative stimulus on the plant cell. If then the cells enlarge after having been occupied by the mites, we must suppose that the latter keep up by their secretions a specific formative stimulus; this stimulus sometimes spreads from one surface of the leaf to the other.

Particularly interesting are the *felt-like diseases* ("*Filz-Krankheiten*") of leaves, the *hair* ("*Erineum*") *formations* on leaves, in which the leaf suffers no alterations in shape; the mites lodge between the hairs and there produce their progeny. These hairs had formerly been considered as fungoid formations; their colour mostly is very bright. They are very differently shaped on the leaves of different plants, but their form may also vary according to the part of the plant. They generally are unicellular formations with a firm membrane, and frequently containing a coloured cell fluid. They are formed by excrescences of epidermic cells which, in their normal state, do not produce hairs either on the superior or the inferior surface of the leaf-blade before this has reached its normal size. It is still unknown whether these hairs are already produced by the eggs, or later on by the mites themselves.

Frank, in a most interesting and convincing manner, describes the origin of the pocket galls and leaf rolls by the prevalence of hyperplasias of the different leaf cells in a perfectly defined direction, whereby not only the formation of the pocket galls with their openings, but also the formation of the leaf roll becomes intelligible. (This interpretation of the mechanism of development vividly reminded me of the first researches by *W. His* on the mechanical causes of the formation of wrinkles in embryos, which subsequently have proved so extremely suggestive of the evolution of forms of organisms.) Abnormal hair formations occur in both cases. It is still unknown whether the eggs, during their development, or later on the mites, after hatching, call forth this development of cells.

Parthenogenesis in the Aphidæ continuing through many generations having been observed, the formative irritation of the eggs, and of the young mite germs, must in this case be kept strictly separated. (Parthenogenesis may, in many respects, be compared with the vegetative multiplication in plants.)

"Many Aphidæ suck themselves fast singly, in consequence of which these closely circumscribed places alone suffer an excessive expansion in the direction of the surface of the leaf blade, whereby the opposite surface of the leaf becomes pushed out, and as it grows forms pockets or bladders which are sessile on the otherwise unaltered side of the leaf, and harbour in their interior the Aphidæ and their brood" (*Frank*).

The investigations of galls of *Diptera* (*flies*) show that the formation of these in single cases had already been incited by the deposition of the eggs (probably by a secretion which, during this act, has been injected into the leaf, or by a secretion attending the growth and development of the eggs). These leaf rolls are even in their younger state frequently found partly empty. "This might be interpreted in this way, that the gall-producing influence may not necessarily be combined with the deposition of the eggs" (*Frank*). In this case it would only, therefore, consist in a chemical effect preceding the deposition of the egg.

It has not yet been decided whether in the formation of galls by *Diptera* on willows, poplars, beeches, alders, and linden, &c., "the egg has been deposited into the inner tissue at the very spot, or whether the young larva, after its development from the egg deposited already externally, has eaten its way to the site of the gall formation" (*Frank*).

The *gall wasps* lay their eggs *into* the leaf, *e.g.*, of the oak.

As the maggots emerging from the eggs must necessarily already find food as soon as they have left the egg it is highly probable that the developing egg has already acted as a formative stimulus upon the leaf cells, and the gall apple has already been formed before the maggots exist. Such a gall apple consists of the following layers: 1. The *external layer* of epidermis, which is sometimes strengthened by a corky layer, and by a more or less thick layer of luxuriant parenchymatous cells beneath; 2. Of a *hard layer* of liquefied, thick-walled, and punctated sclerochymatous cells; and 3. Of an *interior* (*medullary*) *layer* of extremely delicate walled and small parenchymatous cells containing turbid protoplasm which serves as food for the maggots.

From the afore-stated facts it becomes evident that the question whether the gall formation is incited and sustained by a secretion of the mother animal, or by a growth secretion of the eggs, or by special products in the change of matter of the young animals, is still somewhat far from its solution.

We may, however, accept as undoubted *that the products of the animal cells are able to act as a peculiar* (*specific*) *formative stimulus upon the vegetable cells in the same manner as the vegetable cells* (*cocci, bacteria*) *on animal cells.* It is sufficient for me to have here again called to the mind of all the friends of the natural sciences, in the most condensed form possible, this certainly very interesting fact, which brings the animal and vegetable worlds again a step nearer to each other.

In conclusion, may I be permitted once more to return to the vegetable microbes as excitors of formative (hyperplastic) processes in animal cells, namely, the *animal epithelial cells.*

I had previously always spoken only of the formative action of certain microbes on the cells of the connective tissue and vessels. Now we already find in *Baumgarten's* treatise some indications that karyokinetic forms in epithelial cells may also be called forth by bacilli, as in the pulmonary alveolar epithelium by tubercle-bacilli, in the epithelium of the hair-follicles and in the hepatic cells by glanders-bacilli, &c. *Bollinger* maintains for certain that the questionable bodies observed in the *Molluscum contagiosum* in man are not degenerated epithelial cells, but some forms of gregarines. "*J. Pfeifer's* exhaustive investigations on the etiology and pathogenesis of the *infectious epithelioma in birds* admit of no further doubt that the epithelioma-formation is brought about by the immigration of the germs of a *Protozoon* of the class of the *Sporozoa* (*Gregarinæ*) into the cells of the Rete Malpighii. Whilst the cells affected by the parasites are entirely consumed up to a narrow border-line and the nucleus pressed against the cell-wall, *a proliferation of the still intact epithelial cells in the neighbourhood of the invaded region takes place*, the progeny of which are then likewise successively invaded by the parasite, until the multiplication of these has ceased, and the process herewith tends towards recovery." (*Baumgarten*, vol. ii., p. 941.) *

I freely confess that this apparently fully substantiated observation has greatly impressed me. As long as the formative stimulus confined itself only to the cellular elements of the connective tissue, I have considered the existence of a *Carcinoma-microbion* as utterly impossible. The afore-mentioned observation, however, has rendered this more probable. *There are, therefore, microbes which act as a formative stimulus upon animal epithelial cells.* This fact being accepted as proved, we of course remember many phenomena by which the carcinomas and their extension are brought into relation with other microbic diseases, especially the tubercle-formations and their propagation. Then we call to mind, first, the presence of the numerous miliary nodules in the skin as they so frequently appear after extirpation of carcinoma of the breast. Then we think of the slowly developing superficial epitheliomas of the cutis which commence healing in the centre, whilst they slowly continue to luxuriate in the periphery, exactly as in *Lupus*, *Lepra*, and *Psoriasis*. We remember the numerous nodules in the peritoneum and in the pleura (often enough also accompanied by exudations), in which we sometimes are doubtful whether we have to deal with tubercle or with carcinoma nodules. We recollect the mode of spreading of the mammary carcinoma, which bears a resemblance to the radiations of erysipelas ("Erysipelas Flammen"), although they spread more slowly over the whole thoracic skin, and in which we may be doubtful whether the hyperæmia or the formation of the carcinoma is the primary affection. We also remember the transmission of carcinoma into lymphatic glands, which is equally peculiar to all the microbic diseases of tissue, and in which the lymphatic glands act as, sometimes more, sometimes less, permeable filters.

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* *Note by the Translator.*—A kind of mysterious parasitic form of animalculi, known by the name of *Gregarines*, which merely consist of a homogeneous external membrane containing granules and a nucleus, which by some are considered as independent animalculi, by others as intermediate stages of development of intestinal worms of the order of the *Nematoideæ* (*Ascarides*).

We think of the numerous experiments of direct transmission of carcinoma from man to animals, and from animal to animal of the same species, which at last *Hanau* has successfully performed in rats. Could not also immunities and predispositions of different species of animal play an important part in these instances, as in the transmission of the tubercle-bacillus and other kind of microbes? Have we not found in carcinoma exactly the same relations of the excessive primary "epithelial" growth with the formation of granulation-tissue in the neighbourhood, as it exists in the case of the formation of a primary "endothelial" tubercle-nodule with the development of the lymphoid (granulation) tissue? Is there not a certain parallelism between the development of carcinoma and tubercle propagation in their various degrees of activity?

Scheuerlen's Carcinoma-bacillus is supposed to be a very common, harmless saprophyte originating in the epidermis. His careful investigations at any rate deserve every praise. We must not abandon these attempts, nor ought we to be deterred by failures.

If there really exist a carcinoma-microbion it will most probably be a *Bacillus* or a *Sporozoon* (*Gregarine*, *Amœba*, *Plasmodia*). We ought to try to commence our investigations with the acuminate condyloma, with the warts spreading by contact, and with the flat condyloma.

"*He that seeketh, findeth.*" The success would be glorious, not only in the purely scientific aspect, but also as regards the possible deliverance of mankind from one of its direst scourges. If we have succeeded in discovering the microbion the possibility of killing it without destroying the organism will not be excluded.

We are able to kill the recently discovered malaria-plasmodia by quinine and arsenic, the (still doubtful) syphilis-bacilli by mercury and iodine, without injury to the whole organism. We shall also discover means of killing the tubercle-bacillus,* and in like manner we hope to succeed in finding the still perfectly unknown carcinoma microbe in order to save from certain death a body already on the brink of the grave. This is the great task reserved for future generations!

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* *Note by the Translator.*—This sounds almost prophetic, for since the publication of this essay Dr. C. Koch has discovered a method of treating tubercle disease, which at least promises remarkable success.

ABBAZIA ON THE QUARNERO, *Christmas*, 1889.
ON THE SEMMERING, *February*, 1890.

CLINICAL LECTURE

ON

NEURASTHENIA AND ITS TREATMENT.

BY

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SECOND EDITION.

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NEURASTHENIA AND ITS TREATMENT.

GENTLEMEN,

The era of civilisation in which we live has its distinctive pathological stamp conferred upon it by maladies of the nervous system, and above all by neurasthenia and mental diseases. Statistics have proved the quick increase of psychoses, and expression is given to the fact by the rapid multiplication of lunatic asylums. As regards neurasthenia, statistical demonstration of its increase in frequency is not forthcoming; but the experience of physicians, especially of such as enjoy a special confidence on the part of the subjects of nervous disease, indicates quite an appalling frequency of neurasthenic conditions. The causes of this phenomenon are to be looked for in the rapid cultural development of our time. The immense advances all along the line of intellectual, political, and social existence could not have been made without an extraordinary tension of mental forces, and the preservation and development of these new acquisitions entail a continuous exertion both intellectual and psychical on the part of all civilised peoples. The more perfect, the more multifarious the functions of the politician, of the scholar, of the artist, of the merchant, of the artisan, the greater the requirements arising from the exercise and perfection of these functions, so much greater must be the measure of the demands made on the nerve force of the best men in the nation.

But that is not yet all. *Pari passu* with the demands on the working strength of the individual, the extent of his requirements in life, and in the enjoyment of life, grow greater, and that not merely in the coarser, but also in the more delicate forms of enjoyment which consist in the gratification of ambition, in the whole style of existence, in the education of children, and the selection of their walk in life, &c. Contentment in narrow relationships, satisfaction with the performance of duty within the limits of a modest avocation, endeavour to incline children to, and prepare them for, the same sphere,—the same assured walk in life as that which their fathers trod before them—these characteristics are now becoming rarer and rarer day by day. All now desire to get "up higher," not alone for their own sakes, but for their descendants! No one is contented with his lot. The effects of over-population, the steadily increasing competition, the fear of political, financial, and commercial crises are all tending to the same result. Everything is hurrying onwards in the battle for existence and pleasure, and the very bodily movement in our great cities is indicative of this onward rush. There is a universal racing and running to business; no one has time. Only in small towns is the calm observer struck by the quiet progress of the daily toil. There we still see people moving slowly, there only is there time for conversation, for walks, or other recreations.

But if, amid the tireless wear and tear of the great cities, running its convulsive course like clockwork, extraordinary events should happen, if the powers which are already taxed to the utmost in the ordinary avocations of life, should, in addition, have to encounter severe disturbances, should illnesses in the family circle, pecuniary cares, anxieties due to unruly children, conjugal differences, hard times, &c., come into play, then the most elastic disposition breaks down beneath the burden of fate. Experience teaches us, in addition, that even the clearest heads, however well fortune may befriend them in their struggle upwards, may nevertheless have their functional activity impaired by the strenuous and ceaseless character of their labour, through want of repose, and through the unsuitable character of that which they term recreation and enjoyment. Like labour, enjoyment becomes a struggle; where the brain requires rest and indulgence, exciting pleasures and so-called health excursions, accompanied by physical exertion, are taken. Just as too much work is constantly being crammed into too little time, so also is the pleasure of life bolted in concentrated form. The natural consequence is not the repose, strengthening, and invigoration of the overworked nervous system, but a fatiguing exertion in another direction, which leaves in its turn weariness and lassitude behind.

Nowhere are the results of this struggle for existence, this frantic pursuit of gain and pleasure, seen on so extensive a scale as in the United States. It was there that the concept of neurasthenia originated and received its name from Beard. Very significant is it that Beard terms it an "*American disease*," "*which is never absent from a house whose inhabitants are intellectually active.*" Of course it occurs in all other civilised countries, but with far from the same enormous frequency as in the United States. The fact is not surprising to any one at all acquainted with the social relations which prevail in that country. Intensity and hurry of daily work, restlessness during the time devoted to recreation, short and troubled sleep, the strife of competition, chance, and circumstances impart a peculiar character to the social relations of North America, at least in manufacturing and commercial circles.

I have frequently had occasion to give professional advice to such worn-out American neurasthenics, and could place before you a large number of examples. Two instances, however, will suffice.

A middle-aged merchant who presides over a large business house in New York has been suffering for years from sleeplessness, feeling of oppression in the head, sudden terrors, &c. The following is his description of his daily life: "I work strenuously from eight in the morning till ten at night. I have no time for meals. I mostly eat standing, and the food is often cold and insipid by the time I am ready for it. By ten o'clock at night I am so wearied out that I can hardly make the effort to close my books. During the night my work whirls confusedly through my brain, so that it is only towards morning that I can get a few hours unquiet sleep. Then in the morning I feel a dreadful lassitude, and have to take a few glasses of cognac in order to get once more into working order."

A young business man for months incapable of any mental exertion, suffering from sleeplessness and agoraphobia, thus depicts the mode of life which he has been leading for years: "We work from eight till eight. We only have a quarter of an hour for breakfast. In the evening when the business is over we young fellows go at once to the restaurant, where we eat and drink and amuse ourselves till two or three in the morning. Of course I do not get enough sleep, as I have to get up at seven. When I travel for the business, I always do so at night, so as to utilise the day for work."

Is it to be wondered at, gentlemen, that a brain maltreated to such an extent should at last revolt? What is become of Kant's golden rule of life, which allots to man eight hours out of the twenty-four for work, eight for recreation, and eight for sleep? It may still prevail among officials who confine themselves strictly to their allotted work-time, and when it is over have no further need to tax the brain. But these are just the cases in which we do not meet with neurasthenia. In addition to the damage resulting from an exhausting application to business, from a mayhap joyless family life, from financial difficulties, we find debilitation of the nervous system very largely brought about by abuse of *spirits*, of *morphia*, and by *sexual excesses*. It is above all the concentrated forms of alcoholic liquor which weaken the nervous system, diminish thinking power and memory, and at last totally destroy the whole organism. It is quite true that intellectual energy may be momentarily increased by alcoholic indulgence, nay, excited to a considerable degree of functional activity. As time goes on, however, the reaction of the brain to alcohol gradually lessens, and it comes to depend exclusively on external matters, above all on the kind of alcoholic beverage indulged in, how long the organism will resist. Some constitutions hold out long; others, on the contrary, succumb just as quickly.

Still worse are the effects of *morphia*, because the habit quickly leads to rapid increase in the dose, and the injections are required more and more frequently in order to calm the nervous system and restore its functional activity. The tortures of the morphia-neurasthenic are augmented by the fact that although he fully appreciates the injurious effects of the drug, he cannot withstand his craving for it, and thus his life becomes a continuous struggle with his own conscience.

Of especial pathogenetic significance are *sexual excesses*, particularly in adolescents—above all the over-stimulation produced by masturbation, with its consequences, impotence, spermatorrhœa, &c. Excessive sexual intercourse in the natural way, *e.g.*, among young married couples, certainly leads but seldom to nervous debilitation in the absence of other determining causes. Depression of energy, both intellectual and psychical, is on the contrary very frequent among onanists. They become incapable of continuous mental exertion, their memory seems weakened, their energy extinguished. These conditions are doubly injurious, occurring just at the period of mental and bodily development, because the subject, on account of his incapability of mental labour, gets left behind, and irretrievably loses part of the time spent at school. In addition, he suffers constantly from the moral oppression of remorse, from the consciousness that he has deserved his own misfortune, and from all kinds of hypochondriacal ideas about the evil effects of this vice on life and health. This self-torture—which is for the most part quite uncalled for, especially as regards the fear of diseases of the spinal cord—is greatly contributed to by the natural disinclination on the part of the patient to confide in his medical adviser, which results in his wildly resorting, without effect, to all sorts of reading, quackery, and drugging, which only drag him deeper and deeper into the slough of despond.

Finally, a factor of the greatest importance for the development of neurasthenia is *hereditary neuropathic predisposition*, a congenital tendency to conditions of enfeeblement and exhaustion either running in families or existing as a racial or ancestral idiosyncrasy, and not unfrequently both together.

The hereditary stamp is conferred by a neurasthenic father or a hysterical mother. Even in childhood it manifests itself in a marked susceptibility to emotional impressions, but only appears in all completeness during the second decade of years, when intellectual and emotional life attain their riper development. Or it may remain latent under favourable circumstances until a serious misfortune or an unusually great mental exertion or emotional stimulus cause the malady to appear more distinctly. Influences which are supported without difficulty by the congenitally sound often assume a pathogenic significance in these cases. The therapeutic intractability of the disease and its striking tendency to relapse after complete recovery, even in the midst of quite favourable external surroundings, are also distinctive features of hereditary neurasthenia.

Racial and national peculiarities play an important *rôle* in the ætiology of neurasthenia. The Semitic race is especially inclined to neurasthenia. A neurotic strain may even be said to pervade the whole people, despite their great capability for work and steady application. Obstacles and difficulties in the ordinary course of events are overcome by the Jew with astonishing energy and good sense, but an emotional depression, an illness in the family, may utterly paralyse him. The impression made on a susceptible spirit by a melancholy occurrence, for example, the death of a member of the family, especially of a parent, is very profound, and is only very gradually effaced. So also the collapse of a financial speculation, a considerable, nay even a slight pecuniary loss, may elicit all at once the entire group of neurasthenic symptoms. Incapacity for work is not necessarily combined with it; neurasthenia is in these cases principally psychical, manifesting itself by a tendency to mental depression.

The disease takes a different form among Slavonic and Oriental peoples. Among the Russians, especially of the higher class, neurasthenia exists as a fundamental all-pervading trait. In no nation are there so many prematurely worn-out brains, so many young-old men. It is not the fact of being *blasé*, which has its origin in a too early and too vigorous indulgence in the pleasures of life, but a primary tendency to exhaustion of the nervous system, which quickly leads to partial, or total mental incapacity.

The high intellectual productivity and freshness conferred upon advanced age by a healthy frame, by a healthy emotional existence, and by the experience of a laborious life, is rarer in Russia than elsewhere. The fact is attested by the complaints of the choicest spirits of that nation; and the great experience which I have had occasion to accumulate as medical adviser (*consiliarius*) of members of Russian "Society" fully convinces me of the existence of the evils bewailed by these Russian patriots.

If now, after the discussion of the most important ætiological aspects of neurasthenia, we seek to establish a definition of the essence of these multifarious disturbances, we are at once confronted by difficulties, inasmuch as no anatomical changes are hitherto known to correspond to this disease. We must, therefore, content ourselves with regarding the pathological processes as functional, or nutritive and irritative. And these words signify that, having regard to the variability and multiplicity of the disturbances, and to the absence of actual demonstrable organic lesions, we have merely to deal with slight and readily curable alterations. The capability of recovery, and the variability of the (morbid) phenomena, are distinctive, although we often encounter cases which, owing to hereditary taint and a pronounced tendency to recur, assume a severe and incurable character.

We must therefore, as I have just said, be satisfied with defining the nature of the disease from the purely clinical standpoint. I therefore characterise neurasthenia as a *state of functional debility of the nervous system*, varying from the slightest degrees of weakness in a single department, to a condition of complete exhaustion of the entire nervous apparatus. This lack of efficiency is sometimes manifested in the functions of the *intellectual and psychical centres*, sometimes in *those of the reflex and inhibitory centres*, sometimes, finally, in the *paths of nervous conductivity*. Disturbances can, therefore, occur in every department of nervous existence, and it is easily understood how extraordinarily multifarious and protean must be the forms assumed by the disease, not merely in the degree to which the individual forms of disturbance become developed, but also in the combination of various lesions and the kaleidoscopic variations of the phenomena.

It is nevertheless possible to distinguish certain fundamental forms of neurasthenia, as has already been done by *Beard* in his important works, namely, a *cerebral* form or *cerebrasthenia*, a *spinal* form or *myelasthenia*, and a *universal* form in which the entire nervous system participates in the disturbances. To trace an accurate boundary-line between neurasthenic disturbances on the one hand, and the other universal neuroses, especially hysteria and hypochondriasis, and various forms of psychoses, especially melancholia and mania, on the other, is not at present possible. We must content ourselves with admitting that neurasthenia and hysteria often converge, as do likewise neurasthenia and hypochondriasis, so that numerous authors simply join them together. And as regards its relations with melancholy, mania, and hallucinatory insanity, experience teaches that they may develop themselves directly and imperceptibly out of neurasthenia.

Less difficult is it to draw the line between spinal neurasthenia and the other diseases of the medulla spinalis, especially tabes, myelitis, and meningo-myelitis. These and other organic derangements of the cord are seldom liable to be confounded with neurasthenia.

The symptoms of this latter are, as I already mentioned, extremely variable according to the position and character of the most important disturbances.

We shall be obliged, if perfect accuracy be desired, to distinguish almost as many forms of neurasthenia as there are organs in the human body, for the majority may become the seat of neurasthenic disturbances. Quite a number of subdivisions have therefore been made—neurasthenia cordis, enterica, sexualis, &c.—but no real advantage is to be expected from such tabulation. It will suffice if I acquaint you with the most important phenomena, and lay particular stress on those points which are of special diagnostic significance.

The *cerebral disturbances* take the first rank among the symptoms, not only because they are by far the most frequent, but because they involve the greatest amount of damage to the activity of the individual.

The most important of these cerebral symptoms are the following:—

Incapacity for mental work. Here we immediately find countless modifications: mental impotence in every department, or in that one well-defined direction only, in which excessive calls have been made on the brain by professional activity—for example, incapacity for arithmetic in an overworked clerk, for preaching in a neurasthenic clergyman, &c. The extent to which functional power is lost may also vary. The disease may announce itself first of all in a mere lack of *staying power* at intellectual work. The brain of a gifted neurasthenic may yet display a high degree of productivity, for originality, clearness of conception, and richness of imagination, are quite compatible with liability to rapid exhaustion of nerve-power. Beard draws a very pretty comparison between such a brain and a battery of small elements with slight potential power and slight internal resistance, which can develop momentarily an enormous actual power, but quickly become inconstant and prematurely useless.

In such cases the loss of working power is only too often combated by stimulants, and therefore alcohol and morphia play an important part among these patients. They have an oppressive feeling of mental weakness and low-spiritedness, and it is but natural that they should seek to remedy this unpleasant condition so as to be able to discharge their business. It goes without saying that the primary lesion is not removed by such means, which are merely the introduction of fresh sources of damage, and that the easily-exhausted brain is still further injured. It is the fact, however, that in North America neurasthenia goes hand in hand with alcoholism, with morphinism, with cocainism, and the other morbid offshoots of social pathology.

With this intellectual exhaustibility are usually conjoined a series of other phenomena which are quite characteristic, above all the so-called "*Kopfdruck*," the feeling of a permanent *pressure* on the head which is increased by every mental exertion, also *giddiness of the head, pain and tension in the occipital region and nape of the neck, heightened sensitiveness of the eyes to light, sleeplessness, psychical irritability and peevishness.* The nervous asthenopia makes reading difficult for the patient, while, on the other hand, the rapid exhaustion of nerve-force renders him incapable of continuous mental exertion. In this pitiable condition, caused, as it usually is, by their own fault, are the numerous sexual neurasthenics, the onanists, who, being forced to intellectual labour by their position, take up their books again and again in order to study, for instance, to read for an examination, and have to lay them aside again very soon because they do not understand what they read, no trace of it is retained by the memory. In sheer desperation they rush out for an hour's walk, and on their return commence the endeavour again, only to abandon it once more.

In addition there are peculiar paræsthesiæ in the head, feelings as though it were encircled with a hoop, or as if water were shaken up and down in it, or as though the upper eyelids were pressed down. Further, numbness in the face, or in the extremities, with feeling of pricking, or burning, or cold; or as if the limbs "went to sleep," even on the slightest pressure of the bed-cloths against the nerve trunks; noises in the ears and other subjective acoustic sensations; attacks of palpitation; also vasomotor disturbances, for example, epigastric pulsation, perceptible and audible pulse-wave in the ear and head when the latter lies at night on the pillow; sudden feeling of chill or prickly heat, momentary blushing, shooting pains, and finally sudden twitchings in certain groups of muscles, which shoot like electric shocks through the body when the patient is going to sleep.

The multifarious *conditions of fright and horror* with which the patients are afflicted are also characteristic. Sometimes these are to be referred to dreadful occurrences, but generally no cause whatever can be assigned for the special terrifying idea.

The different forms which these states of mental horror assume have given rise to different designations, as if each were a disease *sui generis*. The most widely used of these designations is *agoraphobia*, the *fear of public places* or wide streets, which the patients imagine they cannot traverse alone, whilst they can do it quite well, although not without some persuasion, leaning on the arm of a companion. It is not a fear of any accident, or any other special idea which underlies this peculiar phenomenon, appearing as it does in so many different shapes, but only an indeterminate feeling of uneasiness which overcomes the patient at the view of the public place.

Other patients are attacked by unconquerable uneasiness if they find themselves in an enclosed space with a number of other people, for instance in a theatre or concert-hall, especially if they sit in the middle and have the feeling that they could not get out at once, while they can stand it better if they have a place near the door or in a box.

Others again cannot travel by rail because they have the feeling of being locked into the compartment and could not escape if the uneasy sensations were to come on. I once treated a gentleman who, not because of any dread of a railway accident, but simply through fear at being locked up in the train, performed for a lengthy period his numerous business trips, which often extended over hundreds of miles, in a horse-carriage.

Others suffer, even on slight elevations, from sensations of terror, with vertigo and a feeling of compulsion to throw themselves down. This is only an exaggeration of the vertigo felt by many healthy persons on steeples, &c. To what a degree this feeling can develop was shown me lately by an observation I had occasion to make on an otherwise healthy, highly intellectual man of business, who, up to a short time previously had always lived on the first floor, and subsequently took a beautiful new lodging on the *second* floor, which had low open-work window balconies. The windows looked out on a public square in one direction, and on a wide street in the other. From the first day he complained of uneasiness at the sight of these windows, and this terror became almost invincible, and persisted even at night when the patient lay in bed with the shutters closed. In the back room, which looked out on a small court, the feeling did not come on.

Many patients become uneasy when they are alone, and require therefore to have always some companion. This fear of loneliness naturally leads to quite peculiar, nay to actually comic situations. Years ago I treated a young neurasthenic physician who could not attend to his country practice without bringing his old housekeeper with him. Once when he had persuaded himself to start without her, the uneasiness seized him a quarter of an hour after leaving the town, and he drove back post haste.

Other patients again live in perpetual dread of meeting with human beings, and consequently live like the hermits, and walk in the open with bowed heads, turning away the face on the approach of a man.

Others are afraid of anything and everything which might affect them or make any sort of demand on them, anything which might require a resolution or bring with it responsibility.

Others are afraid of lightning, of earthquakes, of an accident which might befall absent relations, of dust or defilement either in general or caused by quite special materials. These varieties of monomania, which stand close to the boundary of the psychoses, are frequently observed as the sole morbid phenomenon in otherwise healthy individuals. I knew a lady who went about her house almost the entire day to wipe away the dust, and used to wash her hands countless times. Another, the wife of a landed proprietor, also suffered from exaggerated love of cleanliness, and had a particular horror of cart-wheel tar; she used always to examine personally for tar stains the outside garments of her relatives and friends who came on visits to her estate; numerous quarrels between herself and her relatives were thus occasioned.

The dread of disease, especially of contagious disease, is highly developed in many persons. It is related to hypochondriasis, which deduces the presence of definite diseases from symptoms chiefly subjective and for the most part intangible, watches every function of the body with the utmost attention, and strives to attain certainty of diagnosis by reading medical books and constantly interrogating doctors. Later authors assign to hypochondriasis a place among the symptoms of neurasthenia, and Arndt goes so far as to call it a cardinal symptom.

I leave it an open question whether there is any use in conferring special names on all these individual conditions of fear and uneasiness, as has been done by the partisans of a rigorous classification. Listen to these designations—"Agoraphobia" or "Topophobia," fear of public places; "Claustrophobia," fear in an enclosed space; "Monophobia," fear of loneliness; "Anthropophobia," fear of meeting with people; "Mysophobia," fear of dirt; "Phobophobia," fear of attacks of uneasiness; "Pathophobia," fear of diseases; "Siderophobia," fear of being struck by lightning; "Siderodromophobia," fear of railways; "Hypsophobia," fear of heights; "Batophobia," fear of the collapse of lofty objects; "Pantophobia," fear of everything possible. You see, gentlemen, the number of these conditions of fright, and of their Greek-derived synonyms, might be still further increased; but there is no need for such a classification. It suffices to be acquainted with the most important sources of terror with which such patients are tormented. They not unfrequently constitute the most important part of the disease, to such an extent indeed that the other symptoms of neurasthenia are relegated quite to the background.

The phenomena which are most generally found in conjunction with the conditions of fright just mentioned are *vertigo*, with *attacks of pain and spasm in the stomach*, as well as *nausea and tendency to swoon*. These sensations attain an especially high development if the patient cannot escape from the cause of his uneasiness, or seeks to overcome his dread. At the same time there generally arises in addition a painful restlessness in the limbs, an unquiet tendency to walk up and down, feelings of misery and exhaustion, loss of hope, sudden sensations of heat, and perspiration of the hands. *Sleeplessness* also accompanies the conditions of uneasiness, when these latter are persistent and do not allow the patient to rest, even at night. The painful ideas attain a gigantic size during the stillness of the night in the imagination of the sufferer, and excite palpitation, sudden feelings of heat, itching of the skin, *anxietas tibiarum*, so that sleep is driven away for hours and only comes on towards morning. Such conditions are often developed temporarily even among perfectly healthy men, under the influence of severe mental labour, or through sorrow and anxiety, but disappear at once on removal of the cause. Among neurasthenics, however, the feelings of mental uneasiness and despair are altogether out of proportion to the causes, nay, the latter may even be quite unreal, existing only in the patient's imagination.

Another form of *sleeplessness* occurs among such neurasthenics as suffer simply from the excess of mental labour which the brain has for years been compelled to perform, combined with physical exertion and an irregular mode of life. Agrypnia here exists merely in the sense of an absence of sleep; sleep comes not, the patient is wakeful without feeling a craving for sleep until the morning hours, which at last bring a few hours' repose. It is astonishing to what a degree this sleeplessness may attain in men and women of high intellectual development without seriously interfering with their working power. Even when sleep lasts only for two or three hours each night, the patient may nevertheless remain for a long time perfectly vigorous and capable of activity. In the long run, however, this is not kept up, and the longer the disturbance takes to come on, the graver it is. Finally, work is put aside, change of scene resorted to, physical exercise taken, and every other means adopted; but the sleeplessness persists obstinately—more obstinately indeed than any other symptom—especially among patients advanced in years, whose physiological need for sleep is therefore diminishing. The difference in the action of hypnotic drugs in individual cases is also interesting. Whilst the hypnotics proper—morphia, chloral, and paraldehyde—generally act very promptly on patients who lose their sleep through conditions of mental disquietude—however different may be the reaction of individual cases to individual drugs, some who are intolerant of morphia becoming furiously addicted to chloral, and others again attaining sleep only by means of the bromides—the hypnotics have usually no effect worth mentioning on patients who lie awake simply because they feel no need for sleep. They lie, perhaps, more restfully and with pleasanter sensations, but no sleep comes on, so that finally the attempts to produce sleep in such cases by means of drugs are quickly abandoned.

Among the *spinal symptoms*, the *pain in the back* stands in the front rank, in the majority of cases. Sometimes it is a fixed pain in one vertebra or another, sometimes a vague pain in the whole vertebral column, sometimes a feeling of painful fatigue, of creeping, or burning, or pressure; sometimes the pain is called forth by movements, sometimes it is at its worst in the sitting or recumbent posture. Spots painful on pressure are frequently present, especially over the superior dorsal or the cervical vertebræ or their neighbourhood, but in other cases pressure over the spines of the vertebræ elicits no pain whatever.

This pain in the back usually occurs combined with a series of excentric phenomena, and under the name of *Spinal Irritation* was formerly considered to represent an independent disease. These symptoms are now included within the bounds of Neurasthenia spinalis, and it is advisable to completely abandon any separate idea of spinal irritation, as its introduction is liable to perpetual confusion.

The clinical significance of this spinal pain is slight from the medical standpoint, but to hypochondriacal masturbators and other neurasthenics it occasions the most cruel anxiety, for they become convinced, through the violence and persistency of the pain, that it is a symptom of an organic disease of the cord. A thorough objective examination is the only thing which can root this anxiety out of the patient's mind; the lack of all objective anomalies will usually be thus proved for the first time. Diagnostically difficult cases will however sometimes come under observation where a single examination may not suffice to exclude with certainty an anatomical alteration of the cord, especially commencing tabes or myelitis. There are cases in which, in addition to the pains in the back (rachialgia), there are shooting pains and feeling of weakness in the legs, and creeping and crawling sensations in the feet, anæsthesia, impotence, and diminution or exaggeration of the plantar reflexes. Repeated examinations here confirm the diagnosis, on the one hand through the inconstancy of the symptoms both subjective and objective, on the other by the gradual completeness attained by the general neurasthenic impression conveyed. An experienced neurologist will seldom make a diagnostic mistake in such a case.

The astounding multiplicity of the sensory disturbances is manifested as general *hyperæsthesia* and *hyperalgesia* especially in the form of a great susceptibility of the skin to touch or pressure, to heat or cold, to changes of the weather, to many varieties of cloth. We further find the most multifarious *paræsthesiæ* and *anæsthesiæ* in the skin as well as in the deeper soft parts, feelings of cold or heat in the extremities, sweating of the hands and feet or abnormal dryness, creeping or crawling sensations in the skin, transitory disturbance of muscular sensibility as though the legs were not felt at all, as of walking on air, as though the ground yielded to the tread, &c., &c.

Motor disturbances are either absent, or present to a subordinate extent only. A tendency to spasm of the muscles of the calf, of the sole of the foot, of the lower jaw—for example, in the act of yawning—of the intercostal muscles on suddenly turning in bed, of the abdominal muscles in coughing or sneezing, frequently exists. Paralyses are not present; on the contrary, the muscular system is usually capable of high functional activity, and the patients who feel tired and depressed in the house can take walks for hours together without fatigue.

Of the *internal organs* those most frequently implicated are the *heart*, the *stomach*, and the *genital apparatus.*

The *heart* usually displays the most varying conditions of innervation, especially distinct hyperexcitability. On the slightest excitement, and even without any at all, well-marked tachycardia comes on, combined with a series of extremely unpleasant sensations, including not merely the perception of the heart's beat but actual pain, especially in the vicinity of the apex, together with a terrifying irregularity, with the strangest sensations both during and after the pause; with feelings of stoppage of the heart's action, of pushing, of jumping, of twisting of the heart on its own axis, of its leaping up to the throat, &c., &c. These fits of tachycardia are generally accompanied by vertigo, as well as nausea, sudden exhaustion of strength, and feeling of annihilation. For many such patients when they come to the doctor the diagnosis of organic disease of the heart has been for long a matter of certainty, and they are quite unpleasantly surprised to hear that the physical examination reveals no cardiac abnormality. All things considered, cardiac neurasthenia is one of the worst forms, because the patient never gets rid of his uneasiness and anxiety. The mere terror that the palpitation, with its attendant nameless discomforts, might come on, suffices to drive the excitable heart at double its normal pulse-rate.

The sudden effect of psychical influences on the heart's frequency and rhythm are quite characteristic. A pleasant visit, a piece of good news, a short trip to the country, often stills the most obstinate palpitation. I once treated a neurasthenic man of letters, who after several months' torture from irregularity of the heart, was cured in a few hours by a railway journey through a beautiful wintry landscape, and remained for years free from his trouble.

The *stomach disturbances* with which bowel troubles are more or less associated are also highly protean. Amongst prevailing forms are, deficient or capricious appetite, digestive troubles in the shape of abnormal sensations of an unpleasant kind ranging to utter depression and misery, restless wandering about, nausea, large development of gas in stomach and intestine, gaping, &c. Such patients think the period of digestion the most uncomfortable of their existence, while others are attacked on an empty stomach with discomfort or pain in stomach and intestine, or in the head. Many are incapable of any exertion, mental or physical, while fasting, and only come into possession of their strength when they have breakfasted. Others, again, are occasionally seized by ravenous hunger (*Bulimia*) ("Heisshunger"), which compels them to take food at once and in large quantities. A young man, whom I had occasion to observe with Dr. Von Hösslin in his institution, used to have an entire meal brought up and placed on his night table, and devoured it during the night when awakened by the "Heisshunger." An extremely neurasthenic old gentleman of eighty, who had not left his bed for years, would bolt a dozen of eggs at night, when awakened by the "Heisshunger," and would then follow on with soup and other things.

The appetite is extremely capricious; according to the subjective impressions of the patients, it is altogether absent, and yet they often consume and assimilate excessive quantities of food without any particular digestive trouble. The culinary satisfaction of their changeable appetites is a trying task for the housekeeper or cook, especially as there exist often idiosyncrasies with regard to individual foods, particular condiments, spices, &c., which are subject to the same capricious variation as the appetite itself.

Many patients struggle successfully against the digestive troubles by means of bodily exertion, especially by long walks after meals. The comfortable repose beneficial to the healthy after meals does not exist for the nervous dyspeptic; he is driven out by subjective troubles and uncomfortable sensations.

In this form of neurasthenia also psychical influences are of great importance. Pleasant company at table and diversion afterwards diminish the troubles, whilst loneliness, severe labour, distressing circumstances, anxieties, and sorrows augment them to a marked extent. Such over-strained natures consume but little even of select, easily digested food when at home, and never without subsequent discomfort, whilst to their own astonishment when travelling they can go through the whole *table d'hôte* from beginning to end, and swallow and digest the most indigestible things which they would recoil from with abhorrence at home.

The neurasthenic dyspepsias seldom react upon the constitution. But when abstinence, due to fear of the pains, gradually increases, when habitual vomiting or obstinate constipation is present, then a state of nutritive cachexia may come on which cause the patient's own diagnosis of "cancer of the stomach" to appear at first sight not impossible. But after careful taking of the history, physical examination of the patient, and investigation of the contents of the stomach during and after digestion, have all yielded negative results, and in consequence of the variability of the symptoms and complaints, it soon becomes obvious that there is merely gastro-intestinal neurasthenia, and the result of appropriate treatment usually confirms the diagnosis without delay.

The symptoms referrible to the *intestine* consist chiefly of abnormally abundant development of gas, which produces the most unpleasant sensations by distension of the hyper-sensitive intestinal wall. The gas-production may undoubtedly be due to morbid innervation, as is so frequently observed in hysteria. The reason why the gases are not driven out is the extreme tension of the intestinal wall, in consequence of which the muscular coat temporarily loses its contractility. I have proved by experiments on dogs, and also on human beings, that the intestinal wall on being over-distended ceases to react, not only to the motor impulses of the automatic centres, but even to electrical stimuli. Even when the downward passage is perfectly free, in cases of meteorism, the gas does not escape. It is only when part of the gas has been absorbed and the tension somewhat diminished that the automatic impulses begin once more to operate, though very feebly at first; at somewhat irregular intervals, on an average once each minute, the wave of contraction progresses from above downwards. These experiments on the living human subject were restricted, it is true, to the large intestine, the inflation of which was carried out from the rectum (after the inflation the sphincters were kept open by means of a stout tube); since, however, in meteorism, and indeed in the majority of cases, the gas development is in the large intestine, these experiments might be expected to produce reliable results. At any rate they explain how it is that once the conditions for gas production are afforded, the great distension of the colon is so persistent and yields so gradually. Especially troublesome to the patient are the so-called "displaced inflations," felt in the back under the right or left shoulder-blade; they correspond to collections of gas in the flexures of the colon, which latter represent obstacles to the downward passage of the gases.

Disproportionately intense as are the sufferings occasioned by the gaseous accumulation, the relief afforded by the collapse of the inflation is just as great. For hours the sufferer from intestinal neurasthesia keeps on hoping for such a "displaced" inflation to go down; its final collapse is greeted with intense joy, for then only does the mind become clear and the patient capable once more of intellectual exertion.

The obstinate *constipation* which so generally accompanies intestinal neurasthenia naturally favours, to an extraordinary extent, the development of gas, and is the more intractable because the usual purgatives, even the mildest, are either not tolerated or act very unequally, and thereby produce new troubles, so that the patients soon hold all cathartics in disgust.

As regards the *Genital Anomalies* which come under observation as symptoms of neurasthenia, they must be divided into those which are to be looked upon as causes and as effects respectively of the neurasthenia.

As sole or partial cause, the masturbational hyper-stimulation and debilitation of genital excitability comes into play in the male as in the female sex, with this difference, that the disturbances of intellectual working-power become much more prominent among males on account of the duties incumbent upon them, while women seem to be affected rather in disposition, &c.

Impotence of the male, whether complete or incomplete, is a frequent cause of neurasthenic weakness and melancholic depression. Apart from the few who, as old bachelors, do not trouble themselves about their impotence on account of their sexually torpid character, men as a rule are excessively sensitive on this point, and the morally depressing influence of this condition is obvious to the experienced eye in the entire individuality and in every action of the subject. It would lead me too far to go deeper into these matters. They deserve earnest attention on the part of the physician, as much misfortune arises in the world from that cause. I may perhaps take occasion in a subsequent lecture to give expression to my experience and my views on the topic.

TREATMENT.

The principles of the *treatment of neurasthenia* are the direct outcome of the observations I have made regarding its causation and symptomatology. Side by side often with a well-preserved, nay, an actually vigorous constitution we have to do with *a condition of weakness affecting the centres of innervation*, not merely the centres of ideation, of volition, and of memory, but also those of sensation and the automatic centres, reflex and inhibitory. This functional weakness is combined with a heightened susceptibility to external stimuli, in consequence of which the reaction of these latter upon the above-mentioned centres, and their functional manifestations, becomes all the more abnormal.

The treatment must therefore be chiefly directed to restore and strengthen the nervous system, while, on the other hand, it aims at removing the abnormal excitability. Stimuli must therefore be applied, and by their means susceptibility must be lowered. This apparently paradoxical indication may be easily fulfilled if gentle beneficial stimuli be applied which do not increase the excitability, and if the organism be carefully and gradually accustomed to the stronger forms of stimulation by starting with the weaker ones. The habitual sources of injurious excitement; the unrest of daily life; excessive labour, anxiety, excitement, cares; family difficulties; disturbances of sleep; excesses; alcohol; all these must be eliminated until the nervous system has recovered its strength sufficiently to support them without injury. In consequence of the generally unavoidable tendency to return to the former conditions, relapses cannot with certainty be prevented.

If good results are to be obtained, separation from the habitual conditions of life and treatment in institutions specially devoted to the management of such patients, and conducted by medical specialists, are indispensable for many cases, especially for severe and obstinate neurasthenia. Milder cases, especially pure cerebral forms due to over-exertion and chiefly in need of rest, may be very well left free and sent to recuperate in a quiet mountain health-resort where good medical advice is to be had. I will mention later on the external conditions regard to which must be had. *Isolation* and *asylum-treatment* is absolutely indispensable for the more severe cases of the erethic form, with constitutional disturbance, emaciation, sleeplessness, dyspepsia, conditions of uneasiness. No treatment in the family is here of avail, least of all when undertaken amid the usual surroundings. Many cases get on at first quite well at home—a fact patent to every physician who allows himself to be persuaded by patient or friends to attempt a course of home-treatment. The novelty of the treatment exercises a stimulating influence for a while, and the physician's orders are obeyed at first. Soon, however, one recommendation or another is modified or left unfulfilled, the dietetic restrictions are overstepped, and then the relapses come on quickly. At last the treatment is only partly carried out, or given up altogether, because "it is no good." You will therefore do well, gentlemen, no less in your own interest than in that of the patient, *not to undertake a thoroughgoing course of this sort of treatment unless in a private institution*, which affords every guarantee for appropriate medical supervision and reliable execution of all recommendations down to the minutest detail. We have in Germany an abundance of good private institutions. Even a Red Cross nursing establishment, or one of the Deaconesses must suffice if need be, although that important requirement, the constant presence of a house-physician, is not there complied with. In such cases an intelligent and reliable nurse must be provided, and all communication with relatives and friends prevented. All experienced neurologists agree that complete interruption of communication with the external world forms the foundation of successful treatment, while the factor next in point of importance is the attendance of a well-trained nurse, hitherto unknown to the patient. The well-known *Weir-Mitchell* treatment, which has also been recommended by Charcot, Playfair, Binswanger, Burkart, and others, and which has in my hands also yielded the most excellent results in severe cases, rests on this principle. Absolute calm of mind and spirit quickly pacifies the excited nervous system and gradually softens down the abnormal excitability, as indeed we learn by every-day experience in the treatment of the psychoses. Under these favourable external conditions we may accurately gauge the effects of suitable psychical and corporal treatment. The administration of appropriate diet, with massage, electricity, hydrotherapeusis, and medication may now be carried out in complete accordance with the individual indications; especially rest in bed, which is of great value in severe "myelasthenic" cases, may without difficulty be resorted to.

The majority of cases of cerebro-spinal asthenia do not necessarily call for so rigorous a separation from the outer world, nevertheless many of them require treatment with restricted liberty in an institution. A certain moral restraint and strict medical control are not merely desirable, but actually indispensable for the weak-willed patient. The best proof of this is that many patients are quite unwilling at last to leave the institution where at first they had felt very uncomfortable, and immediately return to it in case of a relapse. They are attracted by the feeling of support which the institution and the careful medical supervision impart to their enfeebled self-confidence, no less than by the immediately favourable effects of the physical means resorted to, and they all preserve after recovery a grateful recollection of the institution.

Many neurasthenics do not require the institution treatment, and would even derive no benefit from it. Such are the worn-out minds which threaten to succumb to the daily monotony of work and the daily recurrence of annoyance acting on their own relatively slight power of resistance, without, however, presenting any marked alteration of their physical or mental constitution. There exists in the ranks of the learned professions, no less than among officials and the representatives of industry and finance, an incredible number of such neurasthenics, whose irritability, depending no doubt on their numerous bodily complaints, appears to the uninitiated in the light of the most unendurable capriciousness, and renders its possessor a terror to his subordinates. Such dispositions derive amazing benefit from a somewhat lengthy sojourn among the mountains in summer, or on the northern slopes of the Alps in autumn or spring, with careful hunting, cycling, bathing, gymnastics, country excursions, moderate mountaineering, &c., are greatly to be recommended. It is of the greatest service to young people to compel them to join a gymnastic club; they soon acquire an interest in the bodily exercises, while, thanks to the companionship of their fellow-members, they are charmed out of their apathetic and hypochondriacal state of mind.

Short trips of a few days' duration are also very suitable—to visit a friend, for instance, or a great city, or a watering-place—the new impressions are wonderfully salutary. I have prescribed such short health excursions not unfrequently in midwinter with good results.

It is taken for granted in the foregoing that the patient's physical strength is sufficient, that the bodily exertion does not increase his exhaustion. On this important matter a conclusion must in difficult cases be arrived at by experimentation and observation of results. Beard points out with perfect justice that myelasthenic patients more especially may have their condition positively deteriorated by fatiguing journeys, the lack of domestic comforts, and the hardships entailed by visits to picturesque localities, great cities, picture galleries, &c. My experience quite agrees with Beard's. Be very cautious, gentlemen, how you prescribe so-called recruiting trips. Long journeys are to be undertaken only by the healthy. For the sick, when a change of scene is indicated, it is better to assign them an agreeable but not too remote locality, where the patient can stay some time, and whence he can take longer or shorter excursions according to the state of his strength.

If the patient feels comfortable there, with good lodging and diet, careful attendance and agreeable company, he will also thrive physically, put on weight, he will eat and sleep better; while, on the other hand, the restless excitement of continual locomotion, with all the consequences it entails, only renders him the more unquiet.

The *sea-coast* is very agreeable to some patients as a place of sojourn, and they acquire new strength and freshness every year by sea-bathing. These are for the most part physically robust individuals, who only suffer from a relative excess of mental labour. The stimulating effect exercised by the sea-bathing, and the constant movement through air and water, will be tolerated just as easily as the monotony of the daily life and the surroundings. It is, however, not generally advisable to recommend sea-bathing for sensitive, sleepless, psychically excited or depressed neurasthenics, since it only increases their excitement and sleeplessness. The majestic calm of high mountainous situations acts quite differently.

I must however confess, gentlemen, that even with very great experience it is often hard indeed to come to a conclusion on the question, "Sea-bathing or the Mountains?" and that the answer must often depend on the result of a trial of sea-bathing. For such experiments I would recommend the Baltic bathing resorts as being in all respects the quieter—especially the Islands of Rügen, Usedom, and Wollin, with their magnificent forests stretching almost to the very shore. If the trial turns out favourably, the more strongly stimulating and strengthening North Sea baths may take their turn.

I come now to the discussion of the *physical and pharmacological curative agents* which we have, as auxiliaries, at our disposal, in addition to the therapeutic resources already described.

The *physical agents* are of great value in the treatment of neurasthenia; they are applicable everywhere, whether in an institution or in the patient's private dwelling, but are undoubtedly more efficacious in an institution because they are carried out regularly and methodically, and the best apparatus and arrangements, as well as a skilled staff of assistants, are there available. It is nevertheless quite possible to apply some of these therapeutic agents in the private dwelling to patients who are not in a position to give up their avocations, or they may be sent for a few hours to the institution in order to undergo the treatment quietly and methodically. That is, however, an expedient which should only be resorted to in mild cases; in those of medium, or of great severity, it does not suffice.

Hydrotherapeutics find their application along with procedures which exercise a refreshing and stimulating action on the peripheral nerves, and, centripetally also on the nerve-centres. All shocks and all too strong depressions of temperature must be carefully avoided; both are badly borne by a sensitive and enfeebled nervous system.

The procedure which is at once the gentlest and the most efficacious is the simple *tepid sheet-bath with shampooing*. As it can be done anywhere and costs nothing it is highly applicable in private practice, even among the poorer classes. It is carried out the first thing in the morning. First of all I cause the sheet, which must be large enough to envelope the whole body, to be dipped in water at 24° R. (86° F.) and thoroughly wrung out. With this wet cloth, the rubber—any domestic or servant man can be trained for the purpose—stands before the patient's bed and spreads it out, holding it by two corners with upraised hands, while the patient gets out of bed and lets fall his linen; the operator then wraps it from behind round the whole body of the patient, and rubs his back and legs with the wet cloth, while the patient rubs his own chest and abdomen. The wet sheet is let fall after a minute's rubbing and is replaced by a dry sheet, previously got ready and warmed gently with a hot water bottle or in an oven. The skin is then dried by means of gentle pressure and stroking, and without vigorous rubbing.

I know that professional hydrotherapeutists do not consider this modification of the wet shampoo as efficacious; but I have most distinctly convinced myself in many hundreds of cases that it is this gentle form of rubbing down only which can overcome the first repugnance and render it possible to pursue the treatment. Each day the temperature of the water is lowered by 0·5° R. until 15° R. (65·75° F.) is reached. It is not generally advisable to employ a lower temperature in neurasthenic cases unless the patients are quite hardened lovers of cold water. A moderate addition of common salt to the water heightens its stimulating action, but it should only be commenced after two or three weeks. After the rubbing down the patient should dress at once, and if possible go out into the open air for a while.

If the procedure has been rightly carried out, the patient ought to experience an agreeable sensation of warmth, freshness, and elasticity after being rubbed down. If he feels chilly and uncomfortable the water should be used warmer on the next occasion.

This operation should be continued every morning for months. In milder cases it suffices, combined with suitable diet, to effect complete recovery.

Half-baths, and *cold shower baths* with previous *wet-packing*, or after a short *vapour* or *steam-chamber bath*, are more energetic measures. These procedures may prove very efficacious in somewhat torpid forms of neurasthenia, but on account of the necessity of careful supervision during and after the bath, they should be reserved exclusively for institution treatment.

Short "*full-baths*," *river-baths*, and still better *sea-bathing*, are also very valuable methods of treatment, and cannot be too strongly recommended. Many patients, however, have an idiosyncrasy with regard to river and sea baths, and regularly get chills and feel giddy afterwards. Such patients should not be forced to persist, but their treatment should rather be limited to frictions, &c.

Electricity is also very valuable, as well for generalised application according to Beard and Rockwell's method as for local application in localised forms of neurasthenia, especially those affecting the heart and the digestive tract.

Beard's "general electrisation" has been specially devised for neurasthenics, and the enthusiastic recommendations with which this procedure has come to us from America have also found justification in Europe. The method consists in passing the widely expanded electrode of the positive pole over the entire body-surface, while the soles of the feet are placed upon a damped and warm metal plate, which is covered with flannel and contains the kathode. The an-electrode may suitably be shaped as a roller, so as to glide quickly over the cutaneous surface. According to Beard and Rockwell the current must be strong enough to induce powerful contractions of the superficial muscles. I would recommend this counsel to be adopted *cum grano salis*, at least in the beginning of the treatment. The current ought in my opinion to act only as a *momentary stimulus to the peripheral nerves;* it is then propagated centripetally to the central nervous system, and leaves behind it a feeling of general freshness and invigoration, and also perhaps desire to sleep and renewed appetite. If a too intense current has been adopted the unpleasant symptoms of reaction which the above-mentioned American authors have described are sure to come on—trembling of the legs, coldness of hands and feet, pains in the muscles and in the head, general nervous excitement, &c. These symptoms of reaction may be almost certainly avoided by beginning with a weak current, not continuing the sitting for longer than five minutes, and repeating it only on every second day. When the subject is very sensitive the physician will do well to include himself at first in the chain, and to go over the patient's skin with his own damped hand for an electrode. That is certainly the mildest, the most soothing form of superficial electrisation.

The *constant* current has no special effect applied in this way. Its application in obstinate organic neurasthenias, *e.g.*, of the stomach, intestine, sexual organs, heart, or head, is much more important. The constant current is here of inestimable value as a sedative. In order to develop its full effects however—a point to which I drew attention a considerable time ago—it is absolutely necessary to introduce the current by means of very large electrodes, *i.e.*, with a large sectional area, or else in great quantity, but with slight tension, at any one point of the surface of contact. The effects on pain or uneasiness affecting these organs, on their functions and on the general condition, are in the majority of cases very favourable, in many, actually brilliant. I cannot go further into detail in this place; you will find particulars about mode of application and effects in my work "Electricity in Medicine."

Massage is the third member of the alliance, and is just as useful as the agents just named, and for that reason suitably combined with them, at least at first, in the following way: massage and general electrisation should be applied on alternate days, while hydrotherapy should be daily carried out. In the beginning massage ought to be used gently, and for a short time only (fifteen to twenty minutes), and be gradually extended to one or two hours daily. It is proper to begin with gentle pinching of the skin, in other words with purely mechanical stimulation of the sensory nerves, and with gentle pressing and kneading of the muscles. The vigour of, and the extent of surface included in, the movements of pinching, stroking, kneading, percussion, and squeezing, should be gradually increased, so that the patient finally gets to feel after the massage as though he had been thoroughly beaten.

The effect is very favourable and lasting. The sensibility of the body, the pains, the nervous unrest and sleeplessness, are favourably influenced by massage, whilst on account of the increased muscular metabolism, food-requirement, and assimilation are promoted. These effects are explicable on the one hand by the strong stimulation of the sensory nerves and reaction of these latter on all the innervation centres and their functions collectively, and on the other by the vigorous promotion of the blood and lymph circulation in the skin, subcutaneous tissue, and muscles, whereby tissue change and restitution are actively assisted.

Massage is of the first importance in those severe cases where absolute rest in bed is necessary, and abstention from all bodily and mental activity, even the slightest. Accordingly it plays a leading part in the Weir-Mitchell treatment. Here voluntary muscular action is completely replaced by massage, without resorting in the smallest degree to central impulses.

With regard to the *duration* of the electrical and massage treatment I would counsel moderation. After from three to four weeks one may try an experimental cessation for one or two weeks, during which the patient may undertake a little excursion to test his strength, and, if need be, to acquire renewed patience for a continuance of the treatment.

The *drugs* which may be administered in neurasthenia belong to the classes of *nervine sedatives*, *tonics*, and *hypnotics*. Do not expect too much, gentlemen, from medication in this disease. The bromides alone are frequently very valuable, but only when exhibited in large doses (2 to 3 grams several times daily), especially in the evening, when there is nervous excitement and sleeplessness. They suffice but very seldom, however, as the sole curative agent; they are to be looked upon as mere adjuvants in the complete course of treatment. I prescribe, when necessary in such cases, a mixture of bromide of sodium, bromide of potassium, bromide of ammonium, and sometimes also bromide of lithium in moderate doses, and keep this prescription in force often for several weeks when the result is satisfactory. Some patients like to order something for themselves when they feel miserable, or resort to some previous prescription. Bromides are highly suitable for this purpose. I am in the habit of recommending people who suffer from attacks of terror, or who go about the world in constant dread of such attacks, always to carry about boxes of starch-capsules of bromide in their waistcoat or coat pocket, and take some when the dread of the dread comes on. Water, to drink afterwards, is to be had everywhere. Others who suffer from attacks of weakness, "Heisshunger," and such like, I recommend to carry in their pocket a little bottle of tinct. valerian, tinct. castorei, and sp. æther, $\overline{\text{aa}}$ 5 grams, and a few lumps of sugar, which they can take any time and anywhere. My idea is not so much to assist the patient in the attack as to arouse his self-confidence by the knowledge that he possesses a remedy which may be resorted to at any moment. In cases of "Heisshunger" I get them to carry a little bread or the like in their pockets.

I do not think much of the other nervine drugs by which Beard sets great store—arsenic, cannabis indica, ergotin, caffeïn. In rare cases they may be of some use, but for the most part they serve only for the satisfaction of drug-craving patients.

Beard asserts that he has obtained results from frequently changing the drugs; often he gave sedatives for one week, the second week tonics, the third week he stopped, and then began once more. No German physician will attach any value to such an example; but it must be borne in mind that the Americans are inclined and accustomed to take a great deal of medicine, while in Germany the opposite tendency—a distinct disinclination to employ drugs—is prevalent.

The hypnotic drugs, morphia, chloral, paraldehyde, I only employ in cases of extremest necessity, and then temporarily. To patients suffering from sleeplessness, who have the most intense craving for sleep, I administer chloral or paraldehyde once or twice a week, but then in so powerful a dose that a lengthy and quiet repose is occasioned, and for that purpose a very large dose is often required. The patient must then manage to get along without hypnotics for a couple of days, and this method is continued until the general treatment induces natural sleep. In this connection I should like to point out that a warm bath, or a weak galvanic current diagonally through the head, taken in the evening, act as excellent hypnotics. Others take so much alcoholic drink, and in so short a time, that a sort of intoxication is set up. Beer more especially acts in large quantities as a hypnotic. An old neurasthenic gentleman whom I treated a long time ago had for years been unable to sleep unless he had quickly drank a whole litre of beer lying in bed.

I warn you pressingly, gentlemen, against the administration of *narcotics* in gastro-intestinal neurasthenia, however bad the pains may be—in any case the complaints are not to be taken as seriously as they are made; also against exhibiting digitalis and other cardiac drugs in cardiac neurasthenia with arhythmia and tachycardia. If the attacks are severe a weak galvanic current may be steadily applied to the heart several times daily. It often produces an excellent result, as do also the bromides.

I would also warn you against *purgatives* in general, and especially against their regular administration. Tonics, especially bitters with a weak cathartic action (*e.g.*, tinct. rhei vinos., with tinct. chinæ comp. or elixir aurantior. comp. āā a teaspoonful several times daily), may be occasionally effectual.

External applications, especially the so-called *revulsives*, are sometimes not to be avoided absolutely, but they exercise usually a very slight and temporary effect. They are properly suitable only for very intense and sharply localised neuralgias, especially rachialgia. Violently irritating applications, blisters, and even the actual cautery, applied by means of Paquelin's method, act indeed rather by terrifying or punishing the patient than as curative agents.

Very beneficial, on the contrary, are external applications of *heat* and *cold* according to the particular indication, whether in the form of *rubber bags*, which can be carried about and applied, more especially along the spinal column, or as hot or cold *jet-douches*, which are especially applied to the back, or finally as the so-called "*Scottish douche*," *i.e.*, alternating small hot and cold water jets, each to be continued for eight to ten seconds, and the whole procedure to last from eight to ten minutes. The continuous change of temperature with the constant stimulation is greatly praised by many nervous dyspeptics for its beneficial effects on their digestive troubles and appetite.

To conclude now with the *diet*. Here it is difficult to lay down general rules, because the indications may be different in each case. For this very reason it is only in relatively few cases that value can be ascribed to so regular a course as is prescribed in the Weir-Mitchell treatment, as milk more especially is absolutely intolerable to many persons. Nevertheless the prescriptions of Weir-Mitchell are valuable as showing what quantities of food may be introduced into a stomach almost unaccustomed to nourishment, and what favourable effects on the general body-nutrition and towards strengthening the constitution may thereby be attained. I can heartily recommend to you

Weir-Mitchell's work, "Fat and Blood," and also Beard's on Neurasthenia—both have appeared in German dress—as being really most interesting books. I am not thereby prevented from warning you most urgently against the straitlaced systematic methods of treatment which are flourishing just now and doing much damage in the world. Could we but compute how many people have had their lives sacrificed to irrational fat-reducing treatment and its accompaniments, you would assuredly be astonished at the high mortality. Systematic methods of treatment constitute a great danger in the hands of a physician who does not individualise, and especially in those of a layman.

CLINICAL LECTURE

ON

THE CAUSES OF TUBERCULOSIS.

BY

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manifest when it was found that all the criticism and investigation which followed not only made no essential change but made no important addition to his statements. Every link in the chain of evidence was as firm as the whole.

Physicians immediately accepted the new doctrine, and honourably set themselves to transform their conceptions in accordance with the bacillary hypothesis. That many obstacles to the acceptance of the entire theory existed at first was quite obvious, and the elucidation of separate problems connected with tuberculosis, when regarded from this point of view, seemed attended with insurmountable difficulty.

This was the case in the first instance with the theory of heredity. There is perhaps no fact which has been considered so completely beyond doubt as the hereditary character of tuberculosis. It was the daily observation of the physician that this disease gathered its harvest among the children of tubercular parents. Scrofulous in childhood and tubercular in youth, he saw them grow up and fade away. How, then, is this axiom of experience to be brought into agreement with the bacillary theory?

Different ways of reconciliation have been proposed. Most of them rest on hypotheses which, though supported by some facts, are yet as a whole unsubstantiated. The transmission of tubercle through the father is explained by the supposition that at the time of conception the bacilli are introduced within the spermatozoa. The only argument assigned for this is that bacilli have been found in the testicles of men affected with tubercle. Transmission through the mother, if coincident with conception, requires the assumption that the ovum is infected before fertilisation, or on the passage into the womb. Intrauterine infection is also possible at a later date from the seminal fluid of the father or the blood of the mother. But all these suppositions are only makeshifts, and the want of direct proof for any of them has driven physicians to seek other explanations of the occurrence of tubercle in families. The endeavour to replace the germinal and intrauterine by extrauterine infection is exemplified by the suggestion that has been made by Sée in his work on "Bacillary Tuberculosis," and by Rühle in his lecture before the sixth Medical Congress, and in his article on "Tuberculosis" in my Cyclopædia. This suggestion deserves the greatest attention, were it on this ground alone, that we can do much more to free mankind from tuberculosis, if in place of a heredity which we can only with difficulty modify, we have to deal with various modes of extrauterine infection, the influence of which we can more readily examine and restrict.

As a matter of fact, the means of infection in the child lie very close at hand and in great number. The intimate contact between the infant and its diseased mother or nurse, the kisses of its infected father, the contamination of its food with the bacilli, and the entry of the latter into wounds, all these are modes of infection against which the helpless child has no protection, and the weaker and the less capable of resistance its constitution is, the less protection can it have.

Perhaps infection by means of milk containing bacilli or their spores comes in importance immediately after the direct infection from the relatives. From the frequency of tuberculosis among cattle, the danger from this source is very great, as milk coming from a diseased cow, when perhaps the udders themselves are the seat of tubercle, is infective in a very high degree. The recent experiments of Bollinger and his pupils in this direction have yielded noteworthy results. They found that the milk of cows affected with pleural or pulmonary tuberculosis can infect guinea-pigs, even when the udders are perfectly normal, and the animals themselves are in a very good state of nutrition. Of course the risk from this source is very much lessened on account of the custom of mixing up the milk of diseased with that of sound animals, and five minutes boiling gets rid of the danger altogether. People, however, are apt to display very great indifference towards insidious perils of this kind; even in educated families far too little attention is paid to the source of the milk on which the infant is fed, and the regular boiling, where that is practised, is not looked after with the requisite strictness and care. If this last precaution is left to the cook, then it may be taken as tolerably certain that it is imperfectly done, and I advise you always, gentlemen, to urge on the mother the necessity of preparing the milk with her own hands. This can be best done by means of Soxhlet's apparatus, which, on the supposition that the mother looks after the cleaning of it herself, effectively excludes the possibility of danger to the infant from any micro-organic or chemical source.

On the whole, as we stand at present, we are not yet in a position to estimate the extent of this danger from the food. It is possible, no doubt, that the dread of milk-infection has gone too far, but the frequency of mesenteric disease in children always throws us back on the food as the origin of the mischief. And seeing that the infective influence of the milk of tubercular cattle upon other animals has been pointed out, and that no objection can lie against the validity of the application of those observations to human beings, it is the medical attendant's business to point out to his patients the great dangers to which they are exposed.

There are many other ways of extrauterine infection which can simulate hereditary transmission, and the close intercourse among the members of a family offers abundant possibilities for the exercise of a harmful influence where the parents are tuberculous. Furthermore, if the furniture, the utensils, or the food, are contaminated with sputa containing bacilli, the predisposed children will the more easily be infected, the smaller the dwelling, the larger the family, and the less are decency and cleanliness considered.

But obvious as all these channels of infection may appear from the theoretical point of view, yet practically their influence is of no great importance. Such is the testimony of the results of collective investigation and of the practitioner's daily experience. The transmission of tubercle from diseased persons to others living with them, more especially to husband, or wife, or servants, is so extremely uncommon that the direct infectiveness of the disease from man to man can hardly be so powerful as now and then on *à priori* grounds has been assumed. We must still look to the heredity theory for the explanation of its very common occurrence in the offspring of tubercular parents, and the solution of the many difficulties which surround the question must be sought in the further development of our science.

One special stumbling-block is the long period during which tuberculosis is latent in childhood. Were it the case in congenital tuberculosis, as in syphilis or small-pox, that the fœtus brought with it into the world the symptoms of the disease, the question were easy to decide. But tubercle in the new-born is not plain to the light of day; it behaves somewhat like those rare cases of *syphilis congenita tarda*, where the symptoms do not appear till the second decennium of life, and in which the question whether we have actually to do with congenital or extrauterine infection is yet matter of controversy. That a child is often tubercular, and has been so for years, while it is all the while held as perfectly sound, we sometimes see proved by accident. The examination of a single swollen gland, taken with every precaution from a child apparently in the best of health, will reveal in its interior giant-cells and bacilli. How long have these already been in the body? And are there still other foci of infection in the glands? Who can determine these points?

One more fact deserves mention here. During the last great epidemic of measles in Munich, Bollinger (I learned this in conversation with him), when examining the bodies of children who had died of measles, was able on several occasions to demonstrate the presence of tubercle bacilli in the lymphatic glands, especially in those at the root of the lung and in the mediastinum. The children in question were said to have been previously quite healthy, and more particularly had not been scrofulous. This important statement places in quite a new light the fact that children so frequently fall into tubercular disease after measles. The measles has not caused the tuberculosis; the latent tuberculosis is merely brought to light by the measles. Probably the majority of the cases of tuberculosis in youth are preceded by an affection of the glands of many years standing, the latter so frequently manifesting itself as the scrofula of childhood.

All this, nevertheless, does not prove that the infective agent is present at conception, or *in utero*. It might quite well be that the bacillary invasion has taken place in the first or second years of life, either through a slight wound, a method which some observations render probable, or through infected milk, &c. But we always come back upon the fact that all these possible ways are of actual importance only in the case of children of tubercular or latently tubercular parents. Experience forces on us the assumption that the absolutely sound human organism must have a very great power of resisting the lodgment of the bacillus, and that the latter only finds a permanent abode in the lungs, intestines, &c., when certain conditions are present favourable to the settlement and propagation of the micro-organism. These unknown pathological conditions we call the predisposition to tuberculosis, and mean by that a certain constitution of the tissues of the organism, in virtue of which they afford a favourable soil for the settlement of the virus. Without the assumption of this predisposition, which may be either inherited or acquired, we cannot proceed. Such a predisposition exists for other infectious diseases, such as typhoid, cholera, and dysentery; why not also for tuberculosis?

What this predisposition really is which plays a part in the theory of the ætiology of tuberculosis, second only to that of heredity, we do not know. We know of course in a general way how a man looks who bears a hereditary burden of this sort; we know, further, what causes combine to produce the predisposition; but as to wherein its real nature consists, and as to what are the morphological, chemical, or physiological changes to which it owes its origin, we are quite in the dark. Even the external appearances characteristic of the hereditary tendency, and forming the *phthisical habit* as it is called, often help us very little. The slender frame, flat chest, thin limbs, and delicate complexion, the weakness of the blood-vessels in the mucous membranes and proneness to epistaxis, the liability to laryngeal catarrh, the frequent attacks of palpitation and flushing, the circumscribed malar redness, and so forth, all these are certainly very marked in many cases, but we often also see several or all of them absent. Look at the number of young people in robust health who become tubercular in spite of a well-knit frame, firm muscles, a good complexion, and all the other marks of health!

As for the acquired predisposition, all the weakening influences which attend in so rich measure on human life are the agents for its production. Among these are insufficient food, insanitary dwellings and ways of life, too little sleep, want of fresh air, worries, sorrows, looking after and sitting up at night with the sick, bodily and mental strain, previous illness, childbed, &c. There is no single one of the list that has so deleterious an effect on the resisting power of the tissues and the cells as the want of fresh air and sufficient exercise. The working of these injurious agencies can be most accurately studied among the inhabitants of such places as prisons, convict establishments, and religious houses. Here the restrictions on free movement and the enjoyment of fresh air work in a great many ways, though it may be difficult to estimate the share each of them has in the total result. The essential considerations are these: the air in the apartments which are kept closed, especially in the sleeping rooms, is impure and malodorous, contains dust and low forms of life, is poor in oxygen and rich in carbonic acid; the inspirations with the sedentary mode of life are not deep enough, the lungs are not properly expanded, the metabolism of the tissues in consequence of the want of open air exercise is limited to that attendant on arduous muscular toil, the desire for food becomes less, and its appetising power is diminished by the monotonous character of the dietary. The preparation also of the meals and the quantities allowed often leave a good deal to be desired.

In addition to these in the case of prisoners we have the mental factors: remorse, longing for freedom, desire to see their families, the compulsory intercourse with the scum of mankind, solitary confinement, and the absence of any stimulus whatever. Surrounded by this set of weakening influences the whole organism gets into a lowered condition, in which the ever-present tubercle bacilli readily find admission. It is no doubt generally allowed that in establishments of this kind consumption has gained a firm footing, but the enormous extent to which the inmates fall victims is not perhaps known as it should be. The figures which V. Baer gives in his article in the "Zeitschrift für klinische Medicin" bring out that in prisons the death-rate from consumption is three to four times as high as it is outside. Reckoning the general mortality from consumption as one-seventh, or from fourteen to fifteen per cent., we find that in prisons tubercle is the cause of from forty to fifty per cent., or about half of the total number of deaths. The numbers, of course, vary. For example, in the Austrian prisons the deaths due to consumption in a period of four years amount to 61 per cent. of the whole, while in the Bavarian prisons for a period of eight years they only amount to 38·2 per cent. The death-rate in the different penal institutions also seems to vary according to their construction and organisation. At any rate it is stated that tuberculosis accounts for far more than 60 per cent. of the deaths in the prisons arranged for solitary confinement in cells.

The fact that the mortality reaches its maximum in the later years of confinement is very striking. The infection is thus not simply communicated in these confined quarters as soon as the prisoner sets foot in the establishment; in the majority of instances it requires a process of lowering of the constitution going on for some time to prepare the organism for the settlement of the bacilli.

Many individuals, however, with low resisting power of the tissues fall victims quite early, especially when the contrast between the prison air and the country air they have been used to is a very sharp one, as it is in the case of prisoners from a rural district. This observation is confirmed by the statistics of French and English Army surgeons, which bring out the fact that cases of tubercular disease and deaths from it quickly diminish in number during war or during manœuvres, while in times of peace, especially in winter, when the men are in barracks, they very distinctly increase. Similar causes imperil the lives of the industrial classes in large towns, where they spend their days in dusty, overcrowded workshops, and sleep in close and not very clean rooms at night.

The comparison of the numbers of cases of tuberculosis among industrial and agricultural populations is also favourable to the assumption that the quality and quantity of the respired air are the deciding influences. For example, in Switzerland the mortality from consumption in the former class is more than double that in the latter; the industrial population shows a death-rate from tubercular disease of 2·55 per thousand, the purely agricultural 1·1, while a mixed population gives a rate of 1·7.

Lastly, the statistics from high altitudes distinctly indicate the frequency of phthisis to be in inverse proportion to the elevation. And at very great heights, *e.g.*, in Mexico, in the towns of Mexico, Puebla, Quito, Potosi, and Bogota, all standing at an elevation of from 8,000 to 13,000 feet, tuberculosis is very rare; in spite of the hurtful character of the mining industries it does not occur to any extent even among the labouring classes.

A retarding influence on the development of consumption is observed at an elevation of 1,600 feet, and much more distinctly at one of 3,200 feet. Among the climatic peculiarities of such heights to which this influence may be due we may, I think, discount the effect of the rarified air, for both sea voyages and residence in the Steppes give like favourable results; stress is to be laid rather on the maintenance of the purity of the air by its rapid movement, and on its freedom from micro-organisms. The investigations into the micro-organisms of the atmosphere, undertaken by Miguel and Freudenreich, give, for heights of over 6,500 feet, a complete absence of microbes, and even at a height of 1,820 feet there were very few. Mareau and Miguel also found them nearly altogether absent in the air on the surface of the ocean, and at certain spots on the sea-coast. These results of bacteriological research are, it will be seen, in complete harmony with the physician's experience. No doubt the relative immunity from infection, which we know is enjoyed by residence at high altitudes or on the sea-coast, is assisted by the other aerial agencies at work in such places, the air-pressure, the force of the winds, the amount of contained moisture, and to a certain extent also the energetic pulmonary movements, which are favoured by the co-existence of all these factors.

We shall return to this point when we deal with the treatment of tuberculosis, and go back now to the sources in social life of the tubercular infection. We have spoken of prisons and badly-constructed barracks as such sources. In a similar way tuberculosis may take origin in convents, educational boarding establishments, orphanages, and to some degree in over-crowded day-schools. This happens just in so far as there is insufficient enjoyment of fresh air as a compensation for residence in the infected atmosphere, the insufficiency arising either from the want of proper hygienic arrangements in the buildings themselves, or in the ordering of the daily life of the inhabitants. Convents are the most defective in this respect, and come next after the prisons, the majority of their inhabitants falling victims to tubercle. The life in small badly-ventilated cells, the want of the open air, and the complete absence of bodily exercise and all movements calculated to increase the depth of the inspiration, are the principal factors in bringing about the disease.

The same holds good of orphanages and boarding-schools, in which the pupils are brought up in a monastic seclusion, and partake only to a very limited extent in the benefits of moving about and playing outside the buildings. That the numbers indicating disease in these places are not higher is due partly to the fact that the confinement is not too strictly kept up, but chiefly to the circumstance that the young people do not remain very long in the institutions. Most persons withstand the bad effects of confinement even in prisons for months and years without suffering visibly, and only when the deterioration of the constitution has reached a certain point do the tubercle bacilli begin their destructive work. Statistics of disease in prisons show further that the entry of tubercle into the system is frequently aided by the occurrence of inflammatory attacks in the respiratory organs. Pneumonias which do not regress in the regular way play a prominent part here. No doubt many of these attacks are not merely conditions favouring infection, but the results of an infection which has already taken place. Cases of pneumonia of this kind frequently fall under our observation in hospital. They quite resemble, to begin with, the genuine croupous type, and only the presence of bacilli in the sputum enables us to stamp them as of tubercular origin.

The experience of hospitals in which there are a large number of phthisical cases, either mixed up among the other cases or in special divisions by themselves, is of peculiar value in this discussion. The numbers indicating tubercular disease among the other patients in such hospitals, or among the nurses and servants, are not greater than they are among the general population outside. The physicians, nurses, and officials of the Brompton Hospital for Consumption—the largest consumption hospital in the world—do not, according to Williams's statements, in spite of the bad ventilation and the imperfect cleansing of the spittoons, &c., fall victims to tuberculosis more readily than the inhabitants of populous towns in general, and only three or four cases of the disease could be attributed to infection received in the house. Yet we must not attach too much importance to these numbers, for the attendants in large hospitals, as we know, very frequently change, and it is only rarely that nurses remain for a long period of years in the service. When they do, the number of instances of infection met with is greater.

The religious nursing sisterhoods are in the worst case. Their members (except in the case of those orders who take in hand the attendance on the sick at their own homes) are very little in the open air, and are exposed to all the hurtful influences which I have already shown predispose to phthisis: hard work from early morning to late at night, frequent sitting up during the night, restricted diet, much time consumed in religious exercises, and lastly, too little time for recreation in the fresh air and in the country. Exposed to such a strain as this, it is certainly not surprising if their bodily frames suffer, and offer an easy lodgment to the tubercle bacillus. Here in Munich, among the Sisters of Mercy in our own large hospital, we have seen one after another succumb in the years of youth; we can assume without hesitation that 50 per cent. of them die of tuberculosis. And this not with any hereditary predisposition, but solely as a consequence of work in the hospital and strict obedience to the rules of their order. The young girls who pass into their ranks as candidates come almost without exception from the country. These enter on their work with fresh red cheeks and vigorous frames. After the lapse of a few months, in rare cases after the lapse of years, appears the ominous pallor, which is generally the forerunner of pulmonary hæmorrhage. It would be really too absurd to suppose that these healthy, fresh, country girls were all hereditarily predisposed to tuberculosis; but, in spite of sound constitutions, one after another with dreadful regularity falls a victim.

Is anything more required to prove the direct infectiveness of tuberculosis, or the dangers which attach to the deprivation of fresh air and exercise, the limitation of the hours of sleep, and the want of rest and recreation attendant on the harassing duties of the sick-chamber? I shall return to this question when discussing the prophylaxis; it is so serious a one that all in whose power it lies to change things for the better must lay it to heart.

The final proofs of the direct communication of tuberculosis to the previously healthy are the cases of unintended inoculation of tubercle, cases where a trifling lesion, such as the extraction of a tooth or a slight cut, has led to secondary swelling of the lymphatic glands, and where these glands, when removed, showed giant-cells with tubercle bacilli in their interior. But cases like this are all susceptible of varying interpretation, since the bacilli in them may date their origin from an earlier period, and may have been first brought to light merely through the traumatic lymphadenitis. Doubt can always be thrown on the convincing character of such an experiment, so long as we have no certain criterion of the complete absence of bacilli in the lymphatic glands previous to the occurrence of the accidental inoculation. And we can scarcely indulge the hope of ever attaining to such a criterion.

We have now described all the essential conditions which favour the lodgment of the tubercle bacillus in the human body. It only remains to relate what we know of the way in which the bacilli settle, grow, and spread, and of the forces which the organism can depend upon to guard against them.

The most usual paths of approach into the body seem to be for children the alimentary tract, and for adults the respiratory passages, though departures from these rules probably occur. In the case of the former, the children, the food is probably the medium in which the infective material is conveyed, and tuberculosis of the intestine and mesenteric glands is the result; in adults direct inspiration of the bacilli results in tuberculosis of the lung and bronchial glands. In order that the bacilli may find lodgment in these organs, and multiply there, we require to postulate pathological conditions in the tissues in which the propagation takes place. Pathogenic micro-organisms, which may pass into the various organs in a healthy body, are probably easily shaken off, partly through the activity of its secreting and excreting apparatus, partly also by being taken up into cells, which in all likelihood destroy them, or at all events lower their vitality. Were the normal body not in possession of such defences, the maintenance of its organs in their integrity in the midst of so many microbes would become impossible. In particular, the tubercle bacillus would exercise a most hurtful influence in places like consumption hospitals on those who remained within the walls for a longer or shorter time. And yet from the Brompton Hospital, as I previously mentioned, Dr. Williams reports the opposite, namely, the fact, established by statistics, that tubercular disease among the physicians, nurses, and officials there does not occur oftener than among the town-population in general. Only when we add to the opportunity for infection the fatal predisposition, in which we must assume the existence of small defensive power in the cells against a hostile substance, can we understand the power of the germ to obtain a firm hold of the tissues, and find the necessary conditions for its growth and spread.

I have said that for the protection of the body we must rely, according to our present knowledge, on the maintenance of normal digestion, on the healthy activity of secretion from the bronchial mucous membrane, and on the vital energy of the amœboid cells. We may now consider it as proved that the normal gastric juice digests the bacteria introduced along with the food, or at any rate renders them incapable of reproduction. But on the other hand the various disturbances of function in the stomach, a neutral or alkaline character of the juice, processes of fermentation or decomposition among the contents, all these open the door, and allow the bacteria to pass unhindered. As to their passage into the respiratory tract, the danger of this is a very pressing one, from the fact that the bacilli exist everywhere. The means we possess of guarding against the entrance of foreign bodies with the inspired air are to some extent known, from the examination of sputa from certain persons during life, coupled with the examination of their lungs after death. Very small foreign bodies, such as particles of dust, are, we know, taken up into certain large cells. Nothing is positively known of the origin of these latter, but my own opinion, as I shall explain further on, is that they certainly do not all take rise from the alveolar epithelium, but are probably produced from the flask-shaped cells of the bronchial mucous membrane, perhaps also from the sub-epithelial layer of cells. If dust is inhaled to a moderate extent, for example, by remaining in rooms filled with tobacco smoke, or the smoke of coal or charcoal fires, as among bakers and blacksmiths, we find in the daily expectoration masses of these large round cells, containing the carbon particles enclosed in their interior. In such cases they are got rid of in this way, but when the dust is for ever being inhaled, as among miners and glass-polishers, this process does not nearly suffice. The particles are then taken up by the epithelial layer of the alveoli, and carried through the lymph-stomata into the interstitial tissue, and from there are partly excreted, partly carried along the lymphatics into the bronchial glands. The most convincing illustrations of this are given by the beautiful observations of Zenker and Merkel, who took as the subject of their study the impregnation of the lung tissue with rouge, in the case of women engaged in polishing glass mirrors. Thus the capacity of the lungs for defending themselves by eliminating foreign bodies is, though very considerable, yet limited. Very probably, again, the numbers of these dust-consuming cells and their power of swallowing the foreign bodies are dependent on a certain degree of reactive energy in the bronchial mucous membrane and alveolar walls, while the excretion of the cells themselves is proportioned to the health of the ciliated epithelium and the force of expectoration. A lowering of this reactive energy is the essential condition for the settlement of the bacilli. This view is supported by the fact that there does exist at the beginning of the onset of tuberculosis a want of reactive force in the system, as Baer found among prisoners, and as we see among our Sisters of Mercy. The patients get thin and anæmic, they lose their appetite and strength. There is no cough, no shortness of breath, no respiratory difficulty of any kind, and yet physical examination already reveals infiltration in one or both apices. This is characteristic, of course, only of the more profound degrees of weakness in the cells, such as we get in prisons and nunneries, but in such cases of great weakness we are entitled to infer a lowered measure of resisting power.

I wish here to bring into the discussion a question of practical importance, namely, the causes of the predilection for the apices which tuberculosis shows. That such a predilection exists does not require to be proved; it is the physician's daily experience. Hitherto it has been assumed that the tubercle bacilli settle in the apices on account of the want of inspiratory expansion in these regions, in consequence of which the movement of the air in the bronchioles and alveoli is defective, and this in turn leads to stagnation of the secretions and inflammatory products. On these grounds the frequency of phthisis was explained in people whose occupations entailed sedentary habits and stooping positions, as, for example, tailors.

Hanau, however, has lately expressed an opinion, and supported it as I believe with sound reasons, that the predisposition of the apices depends not on any shortcoming in inspiration, but on the fact that expiration is more difficult in these parts. That the inspiratory powers of the apices are fully developed, we can see very well in a disease like coal-miner's phthisis, where these portions are the first and most seriously affected, and Arnold's experiments on animals are in agreement herewith. And as to the effect of the stooping position in the case of men, this will simply convert the costo-abdominal into almost a purely costal type of respiration, seeing that the downward movement of the diaphragm will be much hindered by the narrowing of the space in the abdomen. Among women, again, the costal is the normal type, and the supposition that in this sex there is insufficient expansion at the apices is *à priori* quite unjustifiable.

While, then, there is no sufficient foundation for the inspiration theory, the expiration theory has all the more to be said for it. Mendelssohn deduced theoretically, and observations made by me on individuals whose thoracic muscles were deficient, definitely proved that in forced expiration the air goes back into the upper lobes, from the want at that part of the thorax of a contractile muscular wall. In this way, during the impulse of coughing, the air there remains stagnant, and for the moment is under high atmospheric pressure. But what is of most consequence to us at present is that the removal, by expectoration, of foreign bodies and micro-organisms from the apices is prevented by the regurgitant current of air, and the contents of the bronchi are thrown right back into the alveoli. No doubt the spiral course of the smallest bronchioles, while it may prove to be in the apex a hindrance to the expulsion of dust and bacilli in expiration, may equally well prevent their being sucked in during inspiration; but it is to be noted that this feature in the anatomical structure of the lung is in any case distinctly unfavourable to the dislodgment of any foreign bodies which have once gained admission. I can therefore only express agreement with Hanau, when he says that the apices are the parts of the lungs which relatively present the most favourable conditions for the entrance of dust and micro-organisms in inspiration, and the most unfavourable conditions for the expulsion of these in expiration. If the tubercle bacilli once gain entrance into these regions, they pass into a state of rest which makes it possible for them to penetrate into the lymph-spaces in the epithelial layer, and fix themselves in the sub-epithelial cellular layer.

Besides this mode of entrance into the system, there is no doubt that invasion may also take place by means of the lymph and blood currents, and we may conclude that this has been the case in the lungs when we find the walls of the lymph and blood vessels the first to be attacked.

After its entrance into the tissues the bacillus, by means of its biological properties, of which as yet we do not know very much, produces an irritant effect, and, as a result of this, reactive inflammation. At this point the struggle between the living cell and the parasite begins, which has been the object of so much recent discussion.

It was observed by Nägeli that this struggle is the very process, in infective diseases, the issues of which are life, disease, and death. The outcome of the contest depends upon the vitality of the cell on the one hand, and the infective force of the schizomycete on the other. If the cell is victorious, the fungus is destroyed ere it has had time to damage the organism; while if the cell succumbs nothing stands in the way of the settlement, multiplication, and spread of the fungus. This idea of Nägeli's (which was held by him in a very general sort of way) in regard to the nature of infection, and the part played by the living cell in the struggle against it, has received a great development in Metschnikoff's phagocyte theory. With all the ambiguity which attaches to the phenomena observed by Metschnikoff, his theory is yet very attractive.

According to him, the function of warding off infection is fulfilled by the phagocytes, as he terms them, cells which are recruited from among the number of leucocytes and fixed connective tissue cells. They appear on the scene on the outbreak of the irritation caused by the invasion of the bacilli, and proceed forthwith to devour the intruders—that is to say, they take them up into their own cell-bodies, and digest them or destroy their reproductive power. They are divided into two groups, large and small phagocytes, macrophagi and microphagi. Among the former Metschnikoff reckons, for example, the epithelioid cells of the connective tissue, among the latter the nucleated leucocytes. These two forms, according to him, play different parts among the different infectious diseases. In his most recent publication he says, for instance, that the streptococci of erysipelas are devoured by microphagi only, but that these latter in their turn are then taken up into the substance of macrophagi, and there digested. In like manner microphagi alone devour the gonococcus, macrophagi the bacillus of the splenic fever of rabbits and guinea-pigs.

According to this author both kinds of phagocytes take part in the struggle against tuberculosis. The macrophagi in the form of epithelioid cells and giant-cells take the principal share in the contest, but the microphagi also are there in great numbers, and indeed are the first to begin the fight. On introducing pure cultures of the tubercle bacilli into the anterior chamber, or under the skin of the rabbit, Metschnikoff found numbers of microphagi stuffed with bacilli as early as twenty hours after the inoculation, this therefore at a time when there could yet be no word of any reaction on the part of the fixed cells. Afterwards the macrophagi make their appearance, and swallow both bacilli and dead microphagi. In this way, according to Metschnikoff, characteristic conglomerate structures originate, in which we find whole heaps of objects that have been eaten, but in which the nucleus of the macrophagus, though hidden, can always be demonstrated.

This theory has met with very active opposition from various quarters. Its opponents allow that schizomycetes are taken up into the bodies of small and large cells, but decline to see in this any tendency to a healing process, preferring to view it as merely a mechanical intussusception of the bacilli, by means of which they gradually undergo certain changes of form. According to Metschnikoff the protoplasm of the cell kills the schizomycetes, so that they are gradually broken up into debris, or at any rate their virulence is so weakened that they are incapable of producing infection. The interesting facts bearing on the relation of phagocytes to tubercular attacks, which Metschnikoff brings forward in his latest publications, are of especial interest as bearing on our subject, and we look forward with some impatience to his promised further contributions on the whole question, and to the controversy to which they will give rise.

It would correspond with the knowledge of the subject of tubercular infection which we gain in practice, were we to assume, first, that a bacillary attack on a perfectly healthy organism is at once turned off and rendered innocuous; secondly, that on a predisposed organism, with a weak cellular energy, while it may not be completely deprived of its virulence, it is made harmless for the moment through the isolative action of the fixed connective tissue-cells; and lastly, that when the bacilli are in great numbers, and the organs are weakened, all opposition is overcome, and death rapidly follows.

In this last connection I may direct your attention to the fact, that it is possible that patients with rapid softening may aspirate pulmonary debris from the cavities into all parts of the air-passages. Such debris contains bacilli, and this autoinfection of parts of the lungs previously sound, explains quite clearly the extensive tubercular pneumonias which are so common in the later stages of chronic phthisis.

Tuberculosis of the larynx is almost without exception a secondary affection following on primary tubercle of the lung. Primary laryngeal tuberculosis, of course, if looked at as a product of infection by inhalation, cannot be said to be impossible, but as a matter of fact the epithelium here seems to present very powerful obstacles to the attack of the enemy. Dr. Kukoff, who has subjected the question to anatomical investigation in our pathological institute, working with the freezing microtome on fresh larynxes from cases that had died of phthisis, could in no single case prove the entrance of bacilli from without, that is, from the sputum hanging about the larynx. On the contrary, the epithelium was in a good state of preservation, and the bacilli that were found had penetrated from the sub-epithelial cellular layer towards the periphery into the intercellular lymph-spaces. There is, of course, no doubt that local infection through the bacilli of the sputum does take place as soon as we have the smallest erosion formed, but this plays no part whatever in the initial stages of laryngeal phthisis. For the explanation of these stages we must refer exclusively to the blood and lymph currents in the laryngeal mucous membrane.

The question of the curability of laryngeal phthisis is now answered in the affirmative. Of course this only in a general way, just in the same way as I have explained above we affirm the curability of pulmonary phthisis. It is certainly not common for tubercular ulcers of the larynx to heal, but I have not the slightest doubt it may occur. I have seen several instances of the affection where, along with a general quieting-down of the tubercular process, the ulcers in the larynx healed up in a short time, and on the death of the patients some years after from repeated phthisical attacks, the cicatrices of these ulcers could be demonstrated. All experienced laryngologists will have seen similar cases.

You see, gentlemen, from what I have said how many questions there are yet to be settled in this great subject before we shall have such a thorough knowledge of all the conditions of the life, activity, and death of the tubercle bacillus, that it will be possible to cut the ground from beneath the feet of this hereditary foe of the human race. But you see also, gentlemen, the immense strides which the theory of the ætiology and the pathology of tuberculosis has made in these last six years, thanks to Koch's discovery. The ardour with which the work is carried on, and the rigidly scientific character of the methods applied, are the best guarantee we have for continuous further progress. This progress practical medicine, in so far as it is interested, will watch with lively sympathy.

ON THE

HEALING-IN OF FOREIGN BODIES.

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ON THE HEALING-IN OF FOREIGN BODIES.

FOREIGN bodies which have gained an entrance into the human organism call forth disturbances and alterations which, in the first place, depend essentially on the locality, that is, the organ concerned, or in other words, on the kind of injury; in the second place, on the nature of the foreign body. As in the following we shall especially consider the reaction of the organism against these foreign bodies with regard to their physical condition, but without reference to the danger of the injury itself, we shall have, in a more restricted sense, to distinguish between the effects of unclean foreign bodies (as we call, for the sake of brevity, those which do not carry with them pathogenic germs), and of clean foreign bodies acting either mechanically or chemically.

The former, *i.e.*, the unclean foreign bodies, have been considered from the oldest times as the deplorable cause of the interest and the treatment in every kind of retention of foreign bodies. The belief in the danger from foreign bodies is mostly based on the experience of the injurious consequences of this first-mentioned kind. At present, however, both the estimate of the case and its treatment begin more and more to agree that these represent merely a fraction of the foreign bodies which come under observation, although already in former times, ever since *Ambroise Paré*, and especially since the time of the great *John Hunter*, the expectant treatment has found observant and thoughtful advocates. The reaction of the organism, apart from the traumatic inflammation, which is eventually due to the specific pathogenic germs, as a rule does not lead to healing-in, and will therefore not come within the scope of this paper.

The reaction in the case of clean foreign bodies, so far as they act in an essentially chemical or toxic manner, experimental pathology has elucidated as regards the effect on the general organism. The knowledge of the local alterations, as a rule, concerns the demonstration of the death of the tissue brought about by certain animal or organic poisons, and the inflammatory reaction of the tissues with exudation, infiltration, and subsequent formation of callosities, or suppuration. The local treatment of the rarer kinds of chemical noxious matter, owing to our still imperfect experience, leaves much to be desired. In the following I shall treat of this group of foreign bodies merely in a cursory way, only so far as they act in consequence of their prolonged presence.

Concerning the pathology of foreign bodies simply acting mechanically, as we shall not consider the injury itself, we have especially to occupy ourselves with the alterations produced by the specific weight, the form, and the surface of the body in question, at the same time we shall, however, not entirely lose sight of the eventual resorbability, *i.e.*, its solubility in the fluids of the body.

The number of instances of healing-in of foreign bodies in the organism is an extremely large one, and the reports on the same, especially in the earlier decades of this century, played an important part in surgical literature. But the older examples have for us lost much of their marvellous character since the conditions of the healing process in wounds has become better understood.

We know that foreign bodies, with the exception of some which act chemically, do not possess as such qualities which cause suppuration, and we are therefore not astonished if they do not produce a violent reaction.

Leber has demonstrated as regards the eye that copper and mercury act as exciters of suppuration. *Grawitz* especially has recently shown that nitrate of silver, croton-oil, ammonia, and turpentine produce suppuration in certain species of animals. Some ptomains have, according to *Scheuerlen*, similar effects. These, of course, may not be instances of progressive suppuration, as no ferment-like substance comes into action.

Older Observations.

The older observations are of but slight importance for the purpose I have in view, because for the most part the anatomico-pathological conditions are not entered into, and only the previous history, the course, and the treatment have been considered. I shall therefore select only a few, but in their way instructive examples.

The foreign body which is mentioned as having been most frequently healed over without reaction is evidently the *steel needle*, especially the *sewing-needle*. It is certain that in a very large number, if not the majority of these cases, needles healed in without causing suppuration. We barely find from the older reports anything worth mentioning as to the kind of reaction. *Breschet* speaks of a white mucus around the needles healed-in under the skin, and states that the metal had become oxydised. *A. Doran* believes that such small inorganic foreign bodies may remain in the tissues without giving rise to any kind of suppuration and *without becoming encapsuled*. *G. T. Weiss* also states that needles have been found "almost" free. *Hodge* accidentally discovered, while dissecting a man, a sewing-needle in the hemisphere of the cerebrum with its point directed backwards, which had been fixed to the dura mater by *old cicatricial bands*. *Von Bergmann* quotes from *Th. Simon* a second similar case. There was in the left hemisphere of a woman, seventy-three years of age, a needle resting upright on its eye, with the point in the left lateral ventricle. There was no defect on the skull above, only a minute external depression, and inside, corresponding to the latter, an exostosis. *Manne* found needles in the meninges near the vertex, which had been the cause of epileptic fits. The needles, according to the supposition of the authors, had been pushed through the fontanelles before the period of ossification.

M. Huppert accidentally found in the heart of an elderly man a sewing-needle sticking in the posterior wall of the left ventricle, and protruding into it with its free end 5—6 mm. It was of jet-black colour, neither rough nor perfectly smooth, and was, as far as it penetrated the wall of the ventricle, covered by a *thin, easily cut, bluish-white pellicle;* whilst the extremely delicate sheath-like investment of the protruding portion of the needle was identified by the microscope as the *pushed-up endocardium*. This was *whitish-opaque and covered with pavement epithelium*. *Sandborg*, who found a needle 9 cm. long firmly sticking in the cardiac muscle, affirms the absence of great reaction after a similar injury. The head of the needle lay in the left ventricle, the remaining portion perforated the pericardium, the diaphragma, the liver, and the wall of the stomach, all which organs were glued to each other. *Gérard*, six years after the injury, found the handle of a knitting-needle in the wall of the left ventricle covered by fibrinous *organised* growths; and *Neill* a much oxydised needle in a cyst of the wall of the left ventricle. In ruminants needles have frequently been discovered in the heart healed in.

The healing-in of *balls* has for a long time been a well-known fact. There are reports of the encapsulation of balls in wheals and sclerotic osseous tissue, or in cystic cavities. *Fabricius Hildanus* long ago stated that a leaden ball might remain for many years in the cavities of the body, or under the fleshy part of the muscles. He once found a ball, half a year after the injury, healed-in between the roof of the skull and the dura mater, " nature having in this place provided a *hard substance* which lay under the dura mater like a pad or a cushion in order to protect it against harm." *Von Bergmann* discovered a revolver-bullet perfectly encapsuled in *connective tissue* in the brain, 0·5 cm. distant from a cerebral abscess. *Koch* likewise found a perfectly encapsuled revolver-bullet in the brain. *Malle* relates that an officer with a gunshot-wound had attained a very old age. The bullet lay in the left hemisphere of the cerebellum. *Cortese* found, nineteen years and a half after the injury, under a defect of the squamous portion of the temporal bone, a protuberance 3 cm. in length, protruding into the substance of the brain, which enclosed fragments of bone, and the ball from which the track of the bullet through the right hemisphere measured 10 cm. to the falx magna cerebri, to which again a pointed, irregularly shaped piece of bone was adherent. The walls of the track, into which the finger could be introduced, *showed under the microscope an unaltered condition of the cerebral paremchyma.* *Hutin* mentions that a ball had remained fourteen years in the vertebral canal healed-in, where it was very firmly impacted; and *Breschet* reports a similar case. Also *von Bruns* speaks of the healing-in of balls in the brain.

Bland, *Ravaton*, *Baudens*, and *Larrey* report numerous cases of healing-in, in closely adherent cicatricial capsules, of *bullets in the lungs*, supporting the assertion of *Koenig* that clean foreign bodies readily become encapsuled in the lungs, by pouches consisting of connective tissue. *Nissel* found a bullet in a cavity of the size of a hen's egg, sixteen years after the injury; and *Guyon* likewise found one in a cyst of the lung. *Suchong* discovered a bullet, bone-splinters, a piece of linen, and a small rag of cloth in a smooth-walled cavity of the right lung ten years after the injury. *Demme* also observed encapsulation of projectiles in the lungs.

The number of instances of healing-in of bullets in the internal organs is altogether very large. *Guthrie, Baroisse, Thompson,* and *Bilguer* found bullets lodged in the *gall-bladder* and the *liver*. *Arnold* found a Chassepot bullet in a cavity separated by a *capsule* from the surrounding tissue of the liver. *Von Bergmann* and *Socin* found a bullet in *the normal paremchyma of the kidney*, merely surrounded by a *thin capsule of connective tissue*.

Percy and *Bojer* observed that in the *muscles of the tongue*, as in general, according to *Ferry*, lead is readily enclosed in the fleshy part of the muscles. In contradiction to *Baudens*, who maintains that shot easily becomes encapsuled in muscular tissue, *Demme* holds that this rarely happens, but he frequently observed their wandering.

The healing-in of bullets in callosities of the heart is well-known to sportsmen. Bullets and wood have been found completely encapsuled in the heart of stags and wild boars.

G. Fischer has collected twelve cases of healed *gunshot-wounds of the heart* in man; of these there are five in which the shot remained lodged in the heart, and in one of these the patient survived his injury fifty-two years. *Latour* describes a case in which a bullet remained six years encapsuled in the right ventricle of the heart. *Galusha* discovered, twenty years after the injury, a bullet encapsuled in the wall of the right ventricle. *Randall* found small shot free in the cavities of the right ventricle and auricle of the heart, and *Vandelli* a bullet free in the right ventricle several years after the injury.

Both *Longmore* and *Demme* observed healing-in by encapsulation of a bullet in the *spleen*.

Demme reports three cases of healing-in of solid shot in the *cancellous tissue of the head of the thigh bone and tibia*. *Simon* had already previously demonstrated the encapsulation of spherical projectiles in the cancellous tissue of the broad articular extremities. *Dementiew* enumerates a great number of instances of projectiles healed-in in joints and bones without causing suppuration. Several authors mention the formation of *callous wheals* and of *a massive callus*. *G. Weiss* states that projectiles produce in bones a rarefying ostitis, but that they eventually are for the most part fixed by eburnified tissue, or embedded in larger or smaller capsules or strata of fibrous tissue. *Fischer* observed that shot which had penetrated into bone are mostly enclosed by fragments of bone; and on the other hand, it has been stated that bone-splinters had been enclosed within the projectile.

Arnold found a bullet lodged on the uninjured seventh rib, clothed by almost unaltered cellular tissue, with which it was intimately connected, whilst it could be *moved about upon the rib.* The *surrounding cellular tissue* was only *slightly thickened. Weiss* mentions the healing-in of a bullet in the hand; and *von Bergmann* once found a revolver-ball between the second and third metacarpal bone in a *firm capsule of connective tissue*, which contained besides the ball a few drops of *serous fluid. Szydlowsky* found a piece of shell connected with the periost of the rib by a *band-shaped callous adhesion.* There was also an angular piece of bone impacted in the metal.

Very frequently in prolonged suppuration only partial healing-in into solid hardened osseous tissue takes place, as, *e.g.*, in the case in which *Kroenlein* extracted a Minié-ball which had kept up suppuration for eleven years.

Ehrmann found a revolver-ball free in the knee-joint.

Fischer diagnosed, in the year 1878, a bullet in an officer which lay under the great pectoral muscle from 1866 to 1876 without causing any reaction, but which afterwards produced suppuration. It was covered by *calcareous deposits*, and *Fischer* states that he constantly found lime on bullets which had produced suppuration during many years.

It may here be mentioned that *wandering of bullets* has, if not frequently, still undoubtedly been observed; the tissue having been worn away by the continued pressure of heavy bullets, which gravitate deeper whilst their track is closed by granulations. I have not yet been able to ascertain in many instances the wandering of small bullets or small shot, which so frequently heal in. *Von Bergmann* is of opinion that gravitation of bullets does not take place as a rule even in soft tissues, viz., the substance of the brain, although *Flourens* had observed it.

Numerous post-mortem examinations prove that *smooth knife-blades* had, without causing suppuration, or any kind of symptoms, healed-in in the cranium, the back, and particularly when impacted in the bone. *Monod* found a piece of a sword-blade 9 cm. in length soldered by osteophytes, and thereby fixed to the inner surface of the left thoracic wall and the ribs. *Gerster* excised a knife-blade 8 cm. in length which had remained healed-in during two years in the fore-arm. *H. Larrey* describes a preparation in Florence, a stiletto sticking for two years in the parietal bone and in the brain; a *pseudo-membrane* protected like a sheath the cerebral substance. *Cuvilliers* extracted the blade of a rapier which, perforating the spinal cord, was healed in the vertebral column; and *Hager* mentions a piece of wire, the presence of which in the thigh had been diagnosed by acupuncture after two years, and which had been removed by an incision "*after dividing the capsule formed by inspissated lymph.*"

Other kind of foreign bodies, remaining without reaction in the body, may be mentioned as curiosities. A particularly remarkable instance from modern reports is the following case of *Huppert:*

At a post-mortem examination of a maniac, aged 42, who in previous years had been mentally normal, was found a *slate-pencil* 7·3 cm. in length, very slightly movable, in the cerebral substance close beneath the floor of the right descending and posterior cornu, with its anterior end touching and fixed to the temporal bone, and with its posterior end embedded in the medullary substance of the posterior lobe, *apparently without causing further anatomical changes*, except the immediate displacement of substance and a *very slight proliferation of connective tissue.* The brain in its neighbourhood was not altered, in the closely surrounding medullary substance there was neither atrophy nor sclerotic thickening, not even any abnormal colouring, there was only on the interior surface of the temporal bone a small osteophyte with remnants of tough white connective tissue to which the anterior end of the foreign body had evidently been fixed. *Huppert* supposes that the slate-pencil, no traces of injury of the bones having been discovered, had been pushed through one of the then still existent fontanelles into the skull, and had remained there latent for so long a period.

Wood heals-in with relative rarity. *Billroth* extracted a thorn 1·6 cm. in length, which had been lodged for eleven years close under the integument of the leg. *Desir de Fortunet* reports a similar case, in which a thorn was removed fifteen years after having penetrated into the latissimus dorsi muscle, where it had caused the development of a fibroma-like tumour. *Klebs* found cotton-thread of 2·3 mm. in diameter healed-in in the soft parts of the fore-arm. If, according to *Bardeleben's* statement, foreign bodies which had entered from the outside into the skin, connective tissue, muscle, bone, nerve, and even brain-tissue, the intestines or also the serous cavities, provided they are of insignificant size, smooth surface, and but slightly irritating quality, cause only an inflammation in their environs of so moderate a degree that they become encapsuled, and if, as he says, small shot particularly lends itself to this, other kind of smooth foreign bodies, such as needles and ligature-thread, most of all glass-splinters, had most frequently been found in *such like cystic capsules*, in cysts, in reference to the formation of which *Gussenbauer* asserts that the question here is not of the formation of fibrous membrane invested with *endothelium* at the surface directed towards the foreign body. *Von Dumreicher* found a piece of glass, 2·5 cm. in length and 2 cm. in width, in the region of the spine of the left scapula encapsuled in a cavity by a *delicate membrane*. *Weiss* likewise found a glass-splinter 8 cm. in length in the humeral region, which had not given rise to inflammatory symptoms. *Hager* and many others discovered in the foot and in the hand healed-in glass-splinters which had lodged there many years.

We find in the more recent surgical literature a large series of healing-in of foreign bodies, with detailed microscopic examinations in reference to the behaviour of silk, catgut, wire, ivory-pegs, and nails, &c., since the introduction of the antiseptic treatment. The respective alterations had been studied most accurately in experiments on animals, with the view of settling important questions of general surgical pathology.

In reviewing the surgical literature of the last decade on this subject, we find descriptions of the minute alterations of tissue in the healing-in of foreign bodies, especially in the abdominal cavity, in the subcutaneous cellular tissue, and in the bone. As regards the healing in the peritoneal cavity, it has been proved by *Spiegelberg* and *Waldeyer*, who made experiments analogous to those of *Rud. Wagner*, *Burdach*, and *Middeldorpf*, that ligatures are encapsuled in the abdominal cavity. Silk and linen fibres showed during the first twenty-one days only a slight swelling, and afterwards a number of cells immigrating from the neighbourhood between the individual fibres. Later on the threads were completely separated, and at odd places totally unravelled.

The surrounding tissues behaved very differently in the sundry experiments: (1) the ligature was encapsuled by *newly-formed thick connective tissue, between the threads there was young granulation tissue;* (2) the ligature lay free in the abdominal cavity after having slipped off from the tied portion, but afterwards it became adherent to other parts, that is, by young cells from the serous membrane growing into it; (3) it lay within a small cystic cavity of the ligatured tissue.

Maslowski proved experimentally that, compared with man, dogs more easily bear metallic ligatures than silk ones, that silk, iron, copper, silver, and silkworm-gut ligatures are invariably encapsuled by *newly-formed* connective tissue (there being at the same time a small quantity of pus around the silk). In dogs the eschar at the cornu of the uterus is not separated by suppuration, but is encapsuled by newly-formed connective tissue, thus uniting it with the surrounding parts.

Wegner found granules of Indian ink which had been injected into the abdominal cavity, and of which only part had been absorbed, enclosed partly in the endothelial cells of the serous membrane, partly in delicate connective tissue. They lay, forming isolated coarser black bodies, close to the abdominal wall or the peritoneal coat of the liver, on which they were encapsuled by a thin layer of serous-like tissue.

Tillmanns implanted pieces of dead tissue, of liver, kidney, &c., hardened in alcohol, into the abdominal cavity of animals, in order to study the process of cicatrisation. He found that the interstices of these foreign bodies actually fill up with colourless blood-cells, and vascular connective tissue finally forms within them. Catgut was absorbed after seventeen days; silk was still unchanged after six weeks, whilst the dead tissue surrounding the silk had long disappeared. *Tillmanns* believes that catgut, and very likely later on the silk also, is destroyed by the intrusion of wandering cells, and is replaced by connective tissue, in a similar way as in the case of the ligatured ovarian pedicle; this view, however, does not agree with the afore-mentioned experiments of *Waldeyer*.

Hallwachs found in dogs, around silk healed-in for eight months in the peritoneal cavity, in close contact with the foreign body a very vascular connective tissue, much resembling granulation tissue, rich in cells, but poor in fibres. Beyond this thin layer there was firm fibrous tissue. He observed between the fibrillæ of a single silk thread small cells embedded in a transparent substance. Around a sponge encapsuled for eight months in the abdominal cavity there was likewise an interior, more injected, and an external firm whitish-yellow layer. Here and there the tissue around the sponge undergoing absorption, resembled organised exudative masses or coagulated fibrine; some particles of the sponge were entirely surrounded by, and interwoven with, vascular granulation tissue. In another experiment catgut had healed-in in a dog six months after the operation; there was at the places concerned young granulation tissue enclosed in tissue composed of irregular fibrous cells—that was the site of the catgut. In a fifth case an elastic ligature had healed-in; in this dog five months after the operation, it was found enclosed in tissue resembling that of the above-described cases, with this difference, however, that numerous crystals and yellow particles, similar to those on the rough surface of the ligature itself, could be recognised within it. *Hallwachs* draws the conclusion that catgut is absorbed and replaced by well vascularised fibrous tissue after six months; that sponges are broken up, silk is encapsuled and unravelled, and elastic ligatures are likewise encapsuled; that the bulk of these objects has decreased in consequence of compression by the living tissue. If an organic substance be enclosed, inflammation sets in, and with an increased flow of fluid, luxuriant granulation and new formation of vascular tissue take place until all the interstices are filled up. In the most minute interstices this is brought about by the tissue-fluids containing cells. No suppuration follows; the foreign body is broken up into most delicate particles (as demonstrated for silk by *Lister*), these are carried away by the flow of blood or fluids, or by the wandering cells, and the cicatricial tissue resulting from it probably disappears at last.

Rosenberger, who introduced sometimes fresh, sometimes dead tissue into the abdominal cavity, observed that dead tissue is enclosed within three to four days by a capsule from which cells immigrate into the foreign tissue; he frequently found giant-cells between the capsule and the foreign body, of which he supposes, agreeing with *Langhans*, that they act as absorbent organs.

(The implanted fresh tissue continues to live in the abdominal cavity after having undergone a loose connection with the abdominal organs. Sometimes a purulent dissolving process takes place in the centre.)

Von Dembowski found that foreign bodies, as ligatures, dead tissue, eschars, certainly produce adhesions, whilst jodoform, blood-coagula, and irritating antiseptic fluids do not. Foreign bodies simply placed into the abdominal cavity always become encapsuled in the mesenteric folds or in the omentum. Jodoform-gauze stitched to the abdominal serous membrane of the right hypogastric region, was after eight days glued to, encapsuled, and adherent to the thickened border of the liver. Jodoform-gauze, sewn from the inside of the internal orifice of the inguinal canal, was healed-in after two weeks between the parietal peritoneum and the omentum, which had assumed the thickness of 3 mm.; the abdominal wall at the site of the gauze had thickened to 5 mm. Catgut ligatures and portions of ligatured tissue are as a rule encapsuled after ten days. Eschars give rise to adhesions with the omentum and the intestines, but not with the liver; they seem, according to *von Dembowski's* view, to be less irritating than the afore-mentioned jodoform-gauze, as has been ascertained after eight days, and also after two months. Solutions of sublimate or carbolic acid, turpentine, and oil of marjoram (Oleum Origani cretici, German pharmacopœia) caused no adhesions. Celloidin favours this, but these adhesions seem to break up again after some time. Whilst in dogs the soldering of eschars to the abdominal wall persisted after several months after the carbonised portion of these had long been absorbed, the celloidin had completely loosened and only the serous membrane still remained much thickened and covered with connective tissue-like layers.

Stern demonstrated that vaseline, mutton-fat, paraffin, olive-oil, and collodium prevent the formation of adhesions of the peritoneum, and are in no manner encapsuled.

Councilman, *Scheuerlen*, and others, introduced under the skin or under the superficial fasciæ glass phials, glass tubes, and similar foreign bodies containing chemically irritating substances. They state that these foreign bodies lay in a cystic space, but that at the same time bands of connective tissue passed through their lumina.

Marchand experimentally investigated the most minute histological alterations. He demonstrated the development of giant-cells, viz., of genuine formations analogous to the giant-cells of tubercle, after introducing silk ligatures or hair, a discovery affirmed by many observers, who found also in man after many years, at a greater or lesser distance from the silk ligatures, isolated giant-cells. *Marchand* made the interesting observation. that *the formation of giant-cells is interfered with, and prevented by, the jodoform*, which adheres to the silk. As soon, however, as the jodoform has been absorbed, the development of giant-cells commences. In the healing-in of sponges, the giant-cells *first form at the periphery* coincidently with the development of fibroblasts and connective tissue.

As regards the structure of the capsule around foreign bodies formed by connective tissue in the peritoneal cavity, as well as in the subcutaneous cellular tissue, it has been stated that its external layers consist of concentrically arranged fibrous connective tissue, poor in cells, whilst the innermost, more vascularised layer, which is also very rich in cells, gradually loses its fibrillar structure and assumes an endothelial character.

Dementiew introduced iron into the cavity of the knee-joint of a dog; after three months it lay surrounded by coagulated fibrine still free in the otherwise healthy joint. Around nickel-plated nails which had been driven from the cavity of the knee-joint into the thigh-bone, the cartilage cells were found perfectly unaltered, but in the epiphysis there was red marrow devoid of fat, consisting of spherical cells and numerous osteoblasts in the place of the yellow marrow. He also states that the osseous tissue in the intermediate neighbourhood of the nails was more densely hardened. The same alterations were observed around a small shot healed-in in the medullary cavity. (The observation concerning the formation of osseous substance in the marrow is contradictory to *Tauber*, who experimented, as is stated, on older animals.)

Waldenburg investigated the tissue alterations around parasites in the Cyprineæ, and found mucous tissue around the homogeneous inner membrane.

It appears from the above observations with regard to the different foreign bodies, if they remain long enough lodged in the body to speak of their healing-in, 1st, that they produce *no* *perceptible reaction*, as, *e.g.*, the sewing-needle, for which there is no histological evidence (this has been ascertained for steel in cartilages by *Dementiew*, and for jodoform-powder in the cavities of the body by *Marchand)*; or 2nd, that they are encapsuled. The latter is brought about in that manner, viz., that the newly-formed connective tissue encompasses the foreign body, or that a larger amount of serous fluid is found between the capsule formed of connective tissue and the foreign body, in which case we have to speak either of *the healing-in in a more or less massy cicatrice, or of cyst formation.*

It is remarkable that at one side the nature of the healing-in of similar foreign bodies in different animals experimented on, as well as in the same individual in different organs, may differ; but that also, on the other hand, certain foreign bodies are found with special frequency in cysts, others again in wheals, which not only lead to the conclusion that the varieties of the injured organisms and organs decide the question, but also that the physical, or as far as the foreign bodies are somewhat soluble, as well as the chemical properties may be of decisive importance.

It must here be pointed out, that very probably a third cause may be of importance for the manner of healing-in, as the organism under different mechanical conditions also differently reacts against the irritation from one and the same external injury.

Whilst stiff bandages, which are equally applied in a larger extent to the surface of the body, even if they fit very tightly, call forth no inflammatory reaction of the skin, the latter will very soon react against the never so slight unequal pressure of a hard foreign body. The effect of that will be materially assisted if the part of the body in question is moved, and thereby at one side the eroding effect of the foreign body, and on the other hand the increased hydrodynamic factors in the body tissues act injuriously. The pressure on the skin is particularly dangerous in portions of the body in which a thin layer of soft parts immediately lies on the skeleton, as in this case even the slightest effect of pressure can barely be counteracted by the elasticity of the thin layers of soft tissue, as from daily experience every coachman knows. Under the stated conditions, as is well known, either erosions or necrosis of the tissue, or formation of wheals, takes place, or that peculiar reaction of the organism consisting in the development of a cystic tumour in the depth between the soft and the hard layers, which we know by the name of bursa mucosa (hygroma).

These apparently digressive statements may indicate the standpoint from which the effect of the foreign bodies remaining inside the body ought to be considered and estimated.

A light, chemically indifferent, small foreign body introduced into a perfectly quiet tissue calls forth no reaction perceptible to the naked eye, as is shown by the behaviour of fine superficial sutures. With the increased size, hardness, and weight of the foreign body, and with the increase of movements, and the fluctuation of pressure of the encompassing living tissue, traumatic inflammation and erosion around the foreign body is gradually brought about, exactly as occurs after external injuries on the surface of the body. As secondary formation of wheals and loss of substance may result on the skin, so we have to expect exactly opposite alterations in the interior of the organism; provided that no kind of tissue alteration takes place, as has been asserted by some authors about needles, and in rare instances also for other foreign bodies, especially as regards the connective tissue, the epidermis, and even the brain and the cartilages.

PERSONAL OBSERVATIONS.

Histological investigations on the encapsulation of foreign bodies.

The older statements on the alterations of the different tissues, on the development of wheals and cysts, on the formation of giant-cells, and the origin of the endothelium in cysts, may be completed by my own observations and investigations.

The following up of the observations of the healing-in of foreign bodies was suggested by a case in the clinical ambulance of Prof. Billroth, at Vienna, four years ago. A lad presented himself with a thin-walled cystic tumour, of about the size of a pigeon's egg, in the bend of the elbow; the skin over it was supple and movable. An injury was inflicted by a piece of a broken window-pane several months previously. The small wound had soon healed by first intention, the tumour gradually formed, and only caused unimportant inconvenience by its size. The smooth-walled cyst was emptied of its clear serous contents by an incision, and a perfectly loose, evidently movable, sharply pointed glass-splinter was extracted.

This observation was followed by a series of similar cases, of which only those in which glass lodged for many months in the body shall be reported more fully, and supplementary to those an account of the description of histological and other details.

Besides the above-mentioned case, the following may be of interest:—

(2) A boy aged thirteen years (Ambulance case-book No. 1844 of Prof. Billroth's clinic for the year 1888) had for eight months healed in the subcutaneous cellular tissue of the head a triangular glass-splinter, about 1 cm. long and 0·5 cm. broad at the base, which was surrounded by a very minute quantity of serum, in a capsule of delicate connective tissue.

(3) A tiler, K. G., twenty-six years of age, presented himself in May, 1889, stating that five months previously he had received from a blow with a beer-glass against the fingers of the right hand a small wound on the dorsal side of the first metacarpo-phalangeal articulation of the first finger, which had soon healed up. Four weeks ago, for the first time he felt inconvenience, and a sensation of pricking accompanied by a resistent infiltration of the skin at the injured place set in, pressure called forth intense stabbing pain. An incision having been made through the firm infiltration, a piece of glass, sharply pointed at one end, about 7 mm. long and 4 mm. broad, surrounded by a most minute quantity of serous fluid, was removed.

(4) A girl, 10 years of age (Amb. C. B. No. 1694, for 1889), ran five weeks ago against a window pane, a splinter of which remained under the frontal integument. It healed up without reaction; later on the cicatrice opened, and a splinter became visible, but soon disappeared again. At present it sticks out from a small opening in the skin. Dilatation of the hole by incision; extraction of the splinter, which was lodged in a *cavity moistened by serum;* no pus.

(5) A man of the fire-brigade, aged thirty-three (Amb. C. B. No. 1983, f. 1889), some months ago, whilst entering through a window, had a glass-splinter thrust into the left knee immediately above the patella. Ointments were applied, and the wound healed without pain, but there remained at the place an induration. Two months ago pricking pain was brought about by bending the leg, or by kneeling. A longish nodosity obliquely above the patella was extirpated, inside which a glass-splinter 16 mm. in length was found in *a small cystic space.* The *capsule consisting of connective tissue* having been excised *in toto*, was divided, its

inner surface treated with a solution of 5 per 1,000 of nitrate of silver, washed with a solution of 7 per cent. of common kitchen salt, and hardened in alcohol, after which sections of the interior wall were made. The microscopical examination of the horizontal and diagonal sections, stained with picro-carmine, showed the external layers of the cyst-wall, consisting of fibrous connective tissue, blending towards the inner surface into a more vascular tissue, poorer in fibres but richer in cells. The cells of the connective tissue increased in size and roundness, so that at the inner surface eventually they reached a diameter of 30 millimetres, but in general they were of different sizes; they varied from spherical to pear-shapes, and possessed larger elliptical nuclei, some of them even 2—3. They were arranged in endothelial manner, and lay so closely together that no interstitial fibrous tissue between them could be seen. The staining by the silver process, although somewhat diffused, still rendered recognisible distinct cell-borders. It appears from the vertical section as if the most superficial cells, *i.e.*, those situated towards the free surface, did not possess any margin, so that the body of the cell seemed directly to pass over into a substance dotted with silver granules. Close under the endothelioid layer there was a very vascular stratum. *(See Tab. I., fig.* 1.*)*

(6) A young man, A. O. (Amb. C. B. No. 2699, f. 1889), fell four weeks previously into a shop window. The wound at the right wrist-joint, situated towards the dorsal side of the epiphysis of the radius, and which bled profusely, was painless, but later on, he stated, it suppurated slightly. He feels in the centre of it a circumscribed hardness. When he presented himself, the wound was covered with a crust of blood, and 1 cm. above it, the point of a foreign body lodged under the skin could be felt. An incision revealed a glass-splinter 2 cm. in length, lying under the superficial fascia in a cystic space, which communicated with the sheath of the tendon of the external radial muscle. The somewhat closely fitting *capsule of connective tissue* contained a small quantity of *pure serous fluid.* No trace of pus, no communication, altogether no connection with the small suppurating external wound. The capsule of connective tissue was hardened first in sublimed picric acid, and then in alcohol. The vertical sections, stained with hæmatoxyline or lithion carmine, showed in the external layers fibrous connective tissue; the cells,

increasing in size towards the interior, assumed a spherical or polygonal shape, became larger, and so numerous that at some places no distinct fibrous tissue between was any longer visible. Very rich vascularisation of the endothelioid layer continued close to the inner surface. At the sharply defined inner border, here and there flattened cells, and regular though extremely delicate bands of fibres. *(See Tab. I., fig. 5.)*

(7) A lad, seventeen years old (Ambulance, May, 1889), two months ago run his hand through a window-pane, inflicting a small wound, which bled profusely, but healed up in eight days. Swelling followed, impeding the movability of the fingers, but soon commenced to mend again, so that the patient was able to do any kind of work (chopping wood, cleaning boots, &c.) Later on the swelling returned. After an incision through the thickened callous skin on the palmar side of the hand, a glass splinter 2·5 cm. long became visible, which stood almost upright on the surface. No fluid escaped from the incision, only the membranaceous investment of the splinter was seen; the latter at one side appeared dull, as if ground.

(8) *Steel needles.* It is to be mentioned, as regards excised *needles* which had been healed-in for a longer period, that these lay in a small canal of connective tissue, with walls of different thickness, containing serum, or directly in a small callosity without any considerable exudation of fluid. A needle which lodged for six months in the cutis of the thumb was tightly enclosed by a firm, but at the same time delicate capsule of connective tissue. Another needle sticking in the thumb was enclosed by a cystic capsule. I extirpated from the palmar side of the hand, near the wrist, a firm capsule of connective tissue, containing a needle healed-in for several months, and a small quantity of serum. The microscopical examination of its walls hardened in sublimed picric acid, and afterwards in alcohol, showed in the external layers concentric bands of connective tissue, with a great amount of pigment, and in the inner vascular layer large cells with a distinct nucleus undergoing division, embedded in the meshes of the scarce, irregularly arranged connective tissue. The innermost border consisted in some places of endothelioid connective tissue corpuscles, or of a delicate fibrous layer. *(See Tab. II., figs. 2 and 3.)* Respecting the above-mentioned abundant brownish-red pigmentation in the external

fibrous layers, I have to add that these gave an intense iron-reaction (with yellow prussiate of potash and hydrochloric acid), as was not the case with an old hæmatoma, which was examined for the purpose of control. It remained, therefore, doubtful whence the iron was obtained, whether it may not have been deposited from the foreign body.

A piece of a needle a few millimetres long was found in a callous cicatrice at the ulnar border of the metacarpus of an hysterical woman.*

An irregular iron splinter in the phalanx of an artisan was likewise healed-in, in a hard callous nodule. Here it may be remarked that *iron* is always found oxydised, even after remaining only a short time in the body.

In a child, twelve months of age (Amb. C. B. No. 3483, f. 1889), was found a fragment of a needle, 2·1 cm. long, sticking vertically in the abdomen, above the umbilicus. Its end could just be felt through the abdominal wall. During the incision through the skin and muscles, the needle showed movements corresponding to the respiration. It was easily extracted from the depth of the abdomen by a moderate traction. It was remarkable that the portion of the needle sticking in the abdominal wall was much more oxydised than that which undoubtedly had entered the peritoneal cavity. The needle had been embedded only twenty-four hours. It was observed in rabbits, seven to eight hours after iron needles had been stuck into and through the abdominal wall, that the degree of oxydation of the needles is very different, according to whether the needle stuck in the abdominal wall, in the abdominal cavity, or in one of the abdominal organs. Especially remarkable is the minute degree of oxydation of the portion of the needle which lay free between the coils of the fat small intestine, whilst the portion situated within the layers of the abdominal wall shows a very strong oxydation. This observation is not without significance in forensic medicine, especially if the chemical condition is constant in the individual regions of the body or organs.

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* This case was of some practical interest, as it was perfectly impossible to feel the foreign body. Here the use of the astatic needle, after previous magnetisation of the fragment, proved efficient, a proceeding which I learned at Prof. Kocher's clinic at Bern, and which had already been practised in England. The needle had already been searched after, but had not been detected by several surgeons. Guided by the astatic needle, I succeeded in discovering it without a longer exploration. (*See A. Smee: On the detention of needles and other steel instruments impacted in the human body. H. Renshaw, Strand, London,* 1875.)

(9) The following case of healing-in of a piece of *lead* is interesting on account of its anatomico-pathological condition.

(*Prof. Billroth's clinic, case-book No.* 379, *f.* 1889), V. H., a cabinet-maker's workman, twenty-one years of age, from Moravia, descended from a healthy family, received seven years ago a gunshot injury from a pistol made out of a key, in the first intermetacarpal space. The barrel of the key, after the removal of the handle, was closed up at one end with lead, and a touch-hole had been filed into it above the leaden plug; the tube was filled with gunpowder, and closed with a piece of fresh clay. The patient whilst holding this improvised pistol with the left hand, ignited the touch-hole with the right hand. The explosion produced a wound near the ulnar side of the base of the left thumb, which bled but very little, and healed under a dressing with arnica and onions (a popular remedy) in three weeks. Later on the patient noticed in the small cicatrice a hard knob, which only caused pain when knocked against. This knob gradually grew within the last ten months into a tumour, in which the patient feels when rapidly moving the hand a pushing sensation. There was at the palmar side of this powerful artisan's hand, between the thumb and the index finger, a slightly movable, fluctuating tumour of the size of a hen's egg, the pale skin over it was thickened and stretched. When shaking the hand a *rumbling sound* was heard, and the *ballotement of a foreign body* distinctly felt. The adduction of the thumb was prevented by the size of the tumour. (*See Tab. III., fig.* 6.)

On the 8th of July, 1889, under anæsthesia and Esmarch's bloodless method, at the palmar side, a longitudinal incision was made across the tumour, by which the bluish-white walls of connective tissue of a pear-shaped cyst, situated in the subcutaneous cellular tissue, was exposed. The skin was somewhat more closely connected with the cyst-wall, only at the part of the small cicatrice at the base of the first phalanx of the thumb, but could be easily and rapidly dissected from this adhesion. The central pointed portion of the cyst was crossed by the fibres of the adductor muscle of the thumb, which for the purpose of the removal of the cyst had to be drawn towards the radius. The whole cyst with its continuation, which reached into the carpus, was peeled out without opening the sheath of the tendon or the articulation. Drainage and union by sutures of the wound. The patient was discharged cured on July 15th. The extirpated tumour was distinctly pear-shaped; an hour-glass-like constriction, which existed whilst the tumour remained in its site, disappeared after dividing a few muscular fasciculi. (*See fig.* 7.)

On opening the cyst an amber-yellow serous fluid, whitish-yellow grumous masses, and a piece of metal escaped. The firm interior wall of the cyst was of yellowish-white colour, uneven, with, at some places, trabecular or wrinkled prominences, of a nodular surface, whilst the other places were perfectly smooth.

The *chemical examination* of the amber-yellow fluid proved its richness in albumen and mucin. There were, moreover, traces of dissolved lead (*Dr. Smita*), but there was no sugar. The *microscopical examination* of the soft grumous substance showed detritus of disintegrated granular cells, and red and white blood-corpuscles. The latter may have found admission in the opening of the cyst, as some blood oozed from the incision of its walls. The *foreign body* lodged in the cavity was of cylindrical shape, 21 mm. long, 9 mm. in diameter, and consisted principally of lead. The almost perfect smoothness of its surface was only interrupted by shallow furrows and pits; it was of grey, at some places of pale brown colour, and nowhere encrusted. (*See fig.* 8.)

The cyst-wall, with the view of histological examination, was treated, one portion with a solution of 0·5 per cent. of nitrate of silver (a few minutes after with a solution of 0·7 per cent. of common salt); another with a solution of 0·5 per cent. of hyperosmic acid (and hardened after that in alcohol); and another portion was directly preserved in Mueller's fluid. Sections made in different directions and stained with hæmatophylin or lithion carmine, showed that the *cyst wall* consisted in the greater part of concentrically arranged *connective tissue*, poor in blood-vessels and cells; only the innermost layers were richer in cells; the *fibrous tissue* loses, when approaching the surface, its regular concentrical arrangement, and at some places appears to radiate, but in a very irregular manner. Finally, the fibrillar structure disappears, so that in the innermost strata, around the cellular nuclei, only an indistinct mass, no longer of a defined structure, can be perceived, an interstitial tissue between the irregular cells. *These cells* possess a distinct nucleus, whilst the outline of the cell is not always clearly visible. Between this innermost layer and the afore-mentioned vascular structure there is at some places a layer of varying thickness of closely packed endothelioid cells, the cementing intercellular substance ("*Kittsubstanz*") of which is rendered distinct on staining by the silver process, whilst the nuclei at the surface are here and there in the act of division. (*See figs.* 9 *and* 10.)

There was no trace of lime-deposits on the piece of lead. I had no opportunity of observing deposits of lime on healed-in foreign bodies, but I once found a considerable quantity around a steel needle, lodged in an abscess in the right iliac fossa, which evidently had perforated from the cæcum. *Fischer* states that incrustation of lime on bullets only takes place in cases of long persistent suppuration.

Another foreign body which I have seen encapsuled in a cystic space was a long steel nail, which was left in a resection-wound, and which was extirpated by *Mr. MacEwen*. Steel nails which had been fastened into bones are frequently so firmly impacted in the bone after five to six weeks, that their extraction may be attended with considerable difficulty.

These observations on human preparations were completed by the investigation of animal preparations. The experiments referring to them were instituted with the view of studying more exactly the tissue alterations around some kinds of foreign bodies, especially of glass, and of testing their fitness for therapeutical purposes.

I shall give in the following some observations as examples:—

(1) *Glass splinters* introduced into the cellular tissue of the neck, the back, or under the fascia of the gluteal region of rabbits, healed-in by first intention. Two months after the operation the following was found: the sharply-edged splinters lay in the aforesaid parts of the body, in cysts containing very little fluid, the walls of which consisted of a white thin capsule of connective tissue, with an inner surface, resembling and shining like a serous membrane. After hardening in alcohol, vertical and horizontal sections were made through the capsule; in the vertical sections were seen distinctly concentric layers of connective tissue, near the inner surface numerous round cells, but no endothelial arrangement of these cells. It was remarkable of

the most superficial layers of the horizontal sections that the fibrillation became less distinct, and that there were relatively large, mostly fusiform cells and an extraordinary abundant, very delicate vascularisation.

(2) Three sharply-edged glass splinters implanted in the left gluteal region, under the abdominal integument, and in the right axilla of a dog, lay after twelve days in a cystic capsule of connective tissue, containing serous fluid rich in albumen. After being hardened in alcohol, the innermost layer presented numerous large-celled formations of endothelioid character, and numerous vessels which with manifold ramifications reached the surface, so that the vessels sometimes seemed to lie free. At many places there were red blood-corpuscles between the endothelioid cells.

(3) A glass splinter healed-in between the abdominal muscles of a rabbit, was enclosed after two months by a thin-walled capsule of connective tissue, containing serum, the inner surface of which was smooth and shining.

(4) A glass splinter in the abdominal cavity of a rabbit, after nine days was enveloped in, and fixed to the omentum.

(5) *A cylindrical solid piece of glass* with rounded edges had been placed in the interstice, between the fractured ends of the left thigh-bone of a dog (from which a piece had been resected with a chain-saw). Sutures in stages; jodoform-gauze; plaster of Paris bandage. After six weeks pseudo-arthrosis in a high degree, considerable shortening of the limb, cystic spaces around the cicatrised displaced ends of the bones, which protruded into these about 1 cm. The glass cylinder lodged in a recess of this space, above the peripheric fragment. A portion of the wall hardened, first in sublimed picric acid, and afterwards in alcohol, presented under the microscope thin layers of fibrillated connective tissue, with numerous connective tissue corpuscles, unequally distributed, most abundant only in certain places, *e.g.*, especially in the recess around the foreign body on the inner surface, without, however, possessing a decidedly endothelioid character. It was remarkable that the fibrillation of the interstitial tissue between the nuclei disappeared at the surface, so that here no distinct structure could be seen. The microscopical examination of the superficial cicatrix of the bone only showed fibrous tissue.

(6) A glass splinter was placed between the fractured ends of

the humerus of a dog. After two months, likewise, pseudo-arthrosis had formed, but only with very little suppuration.

(7) A rounded glass cylinder was placed between the fragments of the leg of another dog. The wound healed by first intention in a dressing of soluble glass. Pseudo-arthrosis after five months.

(8) A thin-walled glass shell was inserted between the fractured ends of the bone of the fore-arm of a rabbit. Plaster of Paris bandage. The fracture was united after two months. At the post-mortem examination, five months after the operation, the numerous delicate splinters of the broken glass shell were found embedded in the abundant callus of the bone.

(9) *Experiment on a rabbit. Glass-wool* was plugged into the knee-joint, in place of the resected left external articular condyle of the femur. The muscles and the skin were united by sutures. *Condition four weeks after the operation:* The knee-joint externally, and in its movability, unaltered. After the removal of the skin, no signs of a preceding injury in the deeper soft parts. A vertical section through the knee below the semi-lunar cartilages brought the latter into view, which, like the tibial articular surface, were pale and moistened with serum, but there was no abnormal effusion, or dropsy of the joint. After the removal of the semi-lunar cartilages, the pale, smooth surface of the internal articular condyle was found unaltered; in the place of the external condyle there was a mass resembling masticated white bread, approaching in shape that of the external condyle, by having its surface rounded. The patella with its tendon glides in a shallow groove of this mass, between both condyles. The line of demarcation of the bone, towards this foreign mass being more vascular than the remaining portion of the bone-surface is visible as a narrow red line. Nowhere extravasated blood or pus, only articular moisture.

The *microscopical examination:* (1) Between the fibres of a small portion of the glass-wool, taken from the superficial layer and stained with hæmatoxylin, only detritus, but no stained cells were visible. (2) In the prepared section of the knee-joint, decalcined in a $\frac{1}{2}$ per cent. solution of chromic acid, especially at the border-zone of the defect of the bone, rich vascularisation between the glass-fibres and the endothelioid cells with a glassy intercellular substance. The osseous structure rarefied. Nowhere marrow containing fat.

(10) *Glass-wool* was placed between the adductor muscles of the thigh of a rabbit; sutures in stages. Six weeks after complete healing-in had taken place, so that the incisions in the several layers of the soft parts could no longer be perceived. The wool was intimately attached to the muscles, no trace of cystic spaces, altogether no serum. The centre of the foreign body (glass-wool), which was also perfectly dry, was at the same time of brownish-black colour, and on superficial examination apparently not grown through by connective tissue. Hardened in a ½ per cent. solution of chromic acid, in the sections, the muscular fibres entering between the glass-threads show no transverse bands, but longitudinal fibrillation. More distant from the muscles there was connective tissue between the glass-fibres, roundish cells of endothelial character, here and there at the same time very numerous vessels in an indistinct clear interstitial substance. On the glass-fibres, as well as on the cells, frequently amorphous pigment. The centre of the glass-wool contained only detritus and pigment. (*See Tab. II., fig.* 4.)

(11) Glass-wool placed in the defect of the cancellated portion of a vertebra of a dog, was found intimately adherent after eight days, and permeated by wandering cells. In the microscopical section, after hardening in chromic acid, besides the wandering cells, the fibrillation of the coagulated fibrine could also be easily recognised. The marrow in the neighbourhood of the injury of the bone contained no fat-cells, whilst these were distinctly present at some greater distance.

(12) Glass-wool placed in the abdominal cavity of rabbits was found intimately adherent, mostly to the intestines and the abdominal wound.

(13) *Leaden projectiles*, and especially *conical bullets* with a circular groove at the blunt end, were in several instances placed in the subcutaneous cellular tissue of rabbits. In the region of the adductor muscles, and in the groin, they were found after four weeks in a cystic space with moderately firm walls, the inner surface of which presented a velvet-like gloss. Under the microscope, enlarged connective tissue corpuscles were visible in the innermost layers, of which again the innermost boundary was undergoing molecular disintegration. A bullet healed-in under the skin of the back, showing numerous cracks and roughnesses, appeared on superficial examination after five

weeks as freely movable and as easily displaced as was the case with the afore-mentioned bullets; on careful preparation, however, it was found that the bullet did not lodge in a cystic space, but was invested by a delicate fine layer of connective tissue, it was grown into the loose subcutaneous fibrous tissue, and was movable with this.

(14) A *cylindrical piece of wood* about 1 cm. long and a few millimetres thick, remained one year and a half healed-in under the dorsal skin of a rabbit. There having been no trace of inflammation, this foreign body only lay in an extremely thin, but distinctly circumscribed white capsule of connective tissue. This was not in immediate contact with the smooth surface of the wood, as there was some serum in the cyst; the two uneven vertical sections of the wood, however, were so intimately adherent to the capsule that they had to be torn off, whereby some blood escaped from the villus-like formations which had grown into the pores of the wood. The cyst-wall was treated with a solution of 2 per cent. of nitrate of silver, stretched across a piece of cork and washed with a solution of 6 per cent. of common salt. It was possible to remove the silver-stained inner pellicle. In horizontal sections, the fibrous tissue, and not very numerous cells of different sizes, without any endothelioid arrangement could be recognised. Vertical sections through the smooth portion of the cyst presented extremely loose tracts of connective tissue and numerous vessels; the interior showed somewhat larger endothelioid cells, and between these structureless interstitial tissue. The place where the wood adhered contained very numerous and large multinuclear cells, and numerous blood-vessels, which also entered the villus-like growths of the connective tissue.

(All the foreign bodies employed in the experiments on animals had previously been sterilised.)

With glass splinters, in general with smooth surfaces or sharp edges of a not too heavy foreign body, encapsulation in a delicate capsule of connective tissue with a smooth internal wall will always take place, provided that the part of the body be not exposed to other kinds of injuries; if, however, the latter be the case, a larger quantity of serum will form, or the capsule will become thickened. Heavier pieces of lead lie in a coarse-walled, not perfectly smooth cyst, or they are closely surrounded by a capsule of connective tissue, which is movable in the cellular tissue. Needles lodge, according to mobility of the soft parts, in thin or thick capsules of connective tissue, which mostly contain distinct serum. Porous fibrous substances are permeated by large-celled connective tissue.

The investigations on the histogenesis of the investments of foreign bodies have already been partially mentioned.

Tillmanns in his treatises on the investments of serous cavities, and again in those on the healing-in of foreign substances, especially of dead tissue in the peritoneal cavity, has in the most exact manner elucidated the more minute histo-pathological alterations. As to the encapsulation of dead bodies in the abdominal cavity, he explained the formation of capsules of connective tissue in the following manner: The formative cells of these are emigrated colourless blood-corpuscles, which in the beginning are round, then so much pressed together that they assume an epithelial appearance, much granulated, possess one large or several smaller nuclei, and sometimes melt together in larger numbers into a homogeneously granular formative material. The formation of the fibrillary substance (respecting which *Tillmanns* coincides with the views of *Ziegler*, *Schwan*, and *Schulze*) is always brought about by differentiation of their protoplasm, whilst in the intercellular substance, so far as it is not understood as a metamorphosed cell-protoplasm, according to *Tillmanns* and *Ziegler*, no formation of fibrillæ is produced. Without exception, the surface of the implanted tissue will be covered in a certain time with cells placed together, in the manner of endothelium.

Quite contrary to this explanation of the mode of origin of the fibrillary substance in the case of foreign bodies, is the view of *Weiss* (*Padua*), who introduced hair or cotton-threads under the skin of dogs or pigeons, in order to examine the tissue alterations after fifteen, thirty, to forty-five days. (He produced, however, with the exception of one single case, always suppuration.) *Weiss* states that in immediate connection with the foreign body giant-cells form, the origin of which he explains by the confluence of several smaller cells; the latter because the foreign body frequently lies in giant-cells. Further, the cells which serve as formative material are granulation-cells. These in time are converted into epithelioid cells, round or polygonous, with finely granular contents, with from two to five finely granulated nuclei, and these epithelioid-cells finally run into giant-cells. Thirdly, the giant-cells are always doomed to fatty metamorphosis, and are converted neither into connective tissue, nor into blood-vessels. *Ziegler* makes the giant-cells form from white blood-corpuscles between glass slides. *Weiss* believes that *Ziegler* might have found giant-cells also outside that capillary space.

As regards the formation of giant-cells, it may be mentioned that *Haidenhain* was the first who observed the development of giant-cells in connection with foreign bodies. *Baumgarten* found such around the ligature after tying arteries, and considers them to be genuine tubercule giant-cells (*Langhanns*), with nuclei attached to the cell-wall ("*wandstaendige Kerne*"). *Marchand*, in his experiments on animals, found likewise genuine giant-cells with twenty to thirty and more nuclei attached to the cell-wall, around healed-in silk fibres, or particles of sponge, besides multinuclear epithelial cells. In contradiction to *Ziegler*, *Tillmanns*, and *Conheim*, who will have them developing from white blood-corpuscles, he considers the foreign body giant-cells to be formed from fixed tissue-cells, not like *Weiss*, from lyphoid, *i.e.*, granulation-cells, but from endothelioid-cells. Thus considering the giant-cells as really living cells, and not like others (*Arnold*, *Thoma*) as a product of degeneration, he believes with *Virchow*, *Baumgarten*, *Flemming*, and others, that they were produced by the growth of one single cell.

The purpose of my own investigations was the study of the microscopic alterations in the environs of the foreign bodies, and at the same time of the histological conditions after healing-in had taken place. On the real nature of the healing-in process, and the participation of the different tissue elements on the above-mentioned theories, on the formation of connective tissue and giant-cells I shall therefore only in passing state my views.

In the microscopic appearances which I observed in the surrounding tissues in the earlier stages of the healing-in of solid foreign bodies, the closely contiguous cells presented, with the vascular loops between them, a kind of granulation-tissue. In the third week the inner layer already showed the character of endothelioid-cells of different size, with or without scanty fibrillæ between them, unless the most superficial layer undergoing continual disintegration presents a structureless substance.

As in older preparations, the gradual transitions from the endothelioid-cells of the inner layer to the delicate connective-tissue corpuscles of the external fibrous layers are perceptible; moreover, as in the more recent preparations of cysts enclosing foreign bodies, as also in the case of healed-in glass-wool, the endothelioid cells have been observed at the same time with the development of a very rich vascular network, I have no reason to doubt the origin of endothelioid-cells for the connective-tissue cells, by proliferation of the latter.

The older preparations are distinguished from the more recent by their *relative* poverty in vessels.

I have further to remark, as regards the formation of giant-cells, that I have never found genuine tubercle giant-cells in the innermost layer of cysts enclosing foreign bodies, but I have observed larger multinuclear endothelioid cells. The innermost layer at any rate does not so very regularly present the formation of giant-cells, as *Weiss* supposes. At the utmost, such formations might be spoken of in some isolated places. Appearances of a sharply-circumscribed mass of protoplasm, with a few spherical cells, were several times observed in the endothelioid layer, in places where the vascularisation was becoming indistinct. The explanation of these as sections through the not yet canalised sprouts of vessels, may not be discarded without further consideration.

The microscopical examination of the cyst-wall around foreign bodies demonstrated mostly large endothelioid-cells, and in many instances also an arrangement of the bands of the connective tissue of the inner layer, which materially differed from that of the external layers of the capsule. As a rule, in each of such cysts, around concentrically arranged tracts of fibres of connective tissue (which in the case of objects which produce very little irritation by their weight or irregular surface, or in quiet animals, *e.g.*, rabbits, are moderately poor in cells; but in the case of heavy rough foreign bodies, and when there is much movement, as, *e.g.*, in an artisan's hand, are moderately rich in nuclei), and also on the inner aspect of these layers of connective tissue in which the concentric arrangement of the fibrillæ is lost, and the fibrillæ themselves become irregular, the lumen of numerous vessels is observed, while at the same time the cells around the connective-tissue nuclei become more distinct and more rounded, until finally immediately at the surface they are less densely packed together, and show quite irregular conditions of growth and multiplication. Frequently the increase in size of the cell is associated with so considerable a decrease of the fibrillary intercellular substance that a whole layer of cells appears to be in direct contact with it, or at least only separated from it by a very minute amount of intercellular substance, structureless, or consisting of extremely delicate fibres.

A sharp boundary-line towards the interior is frequently absent, in many instances there may be seen a granular mass, which perhaps may have been produced by the disintegration of the cells and intercellular substance, in which here and there a larger nucleus may still remain visible. Moreover, if the cells have no endothelioid arrangement, and if between them there are still visible distinct connective-tissue fibres (not arranged concentrically, but rather radially), then the more or less smooth inner surface may also be formed by such a layer of most delicate fibres. In closely-adjacent delicately-walled connective tissue capsules around quiescent smooth foreign bodies, the layer of the enlarged connective-tissue corpuscles and their increase in number are very inconsiderable; the delicate fibre-bands are concentrically arranged almost up to the inner surface.

In the examination of older cases, a condition which might indicate cellular infiltration of the walls could never be demonstrated; it is only a question of increasing growth of the connective-tissue cells and final proliferation of these (and degeneration of the protoplasm), and in the same succession of retrogressive metamorphoses of the intercellular substance from the gradual indistinctness to the complete disappearance of the fibrillary structure.

I never succeeded in finding a genuine endothelial layer in a cyst formed around foreign bodies, as had been demonstrated by *Landzert*, *Boll*, *Bruecke*, *Reichert*, *Koelliker*, *Heineke*, and especially by *Tillmanns*, for the inner surface of articulations, in contradiction to *Albert*, *Hueter*, *Gerlach*, and others.

It barely needs mentioning that the same beautiful appearances which *Tillmanns* and others of the afore-named authors have seen in articulations, had likewise repeatedly been produced and observed in favourable preparations. In the case of cysts around foreign bodies, even if they contained the clearest serum, and if their walls appeared perfectly smooth and shining, the most varied preparations, also those produced by the very unreliable silver-process ("*Silberbilder*"), never yielded similar results, as, *e.g.*, in surface preparations ("*Abstreifpraeparaten*"), including the transition from articular cartilage to synovial capsule. It seems that there is never a cellular-investment layer strictly differentiated from the other kinds of connective tissue.

As little can an endothelial investment of the kind be observed, as has been found in hygroma of the sheaths of the tendons (in tenosynovitis). In these, by an injection of a solution of ½ per cent. of silver, an endothelial layer of two to three strata of large pear-shaped, also of spherical cells with large distinct nuclei, can be demonstrated in glycerine preparations, a condition which cannot be found in secondary hygromas, so-called "bursæ mucosæ," or accessory bursæ, the inner wall of which rather reminds one of the afore-described capsules around foreign bodies, as the large, irregular, densely-arranged cells of their inner wall, the trabeculi and septa, possess in every respect the character of the connective-tissue cells.

In the case of foreign bodies partially lodged in physiological cavities with epithelial or endothelial investment, an advance of this epithelium or endothelium to the remainder of the wound —a genuine epithelial investment of walls being thus formed— is, from a theoretical standpoint, certainly admissible. I myself have no experience of this occurrence.

If the injury be considerable, the inner wall presents the appearance of wearing away of the connective tissue with persistent irritation and disintegration of the innermost layer; if the injury, however, be but slight, there will be signs of a lesser degree of irritation (of cell proliferation) in the fibrillary tissue.

The distribution of the vessels is highly remarkable. There is in every case a poverty of vessels in the external layers of the capsule, and an extraordinary richness in the inner layers; but there are also varieties of termination and distribution of the vessels in the richly vascularised inner layer, and whilst in some cases the ends of the vessels evidently do not advance to the surface, where, on the contrary, they are wanting between the most superficial endothelioid cells, the particularly rich vascular network is in other cases of more recent origin so superficial that in general there can be no certainty that there is still another layer of cells above the vascular wall.

If we examine from the teleological standpoint the tissue alterations at the end of the process of healing-in of foreign bodies, we shall find that the organism in general strives firmly to encompass the foreign object in order not to give it room to have wearing-away or eroding effects. This will not occur in the case of relatively heavy, very pointed or sharp foreign bodies, or under all circumstances, though the weight may be never so slight, in the case of perfectly smooth foreign bodies, as in this case there will be no absolute and persistent contact between the object and the same portion of tissue. Again, profuse exudation may, to a certain degree, in a movable organ protect the tissue against the mechanical effects, as the foreign body balloting in a large cyst cavity will, at least not continuously, prick, cut, or in general touch the same spot; under complete rest the amount of serum will be reduced to a minimum.

Even the silk thread, which in the cutis or in the fatty tissue in most cases heals-in in a small callosity, may be found in a cyst in the neighbourhood of a pulsating blood-vessel or in the muscles. In this case it is not the movement of the foreign body, but the movement of the tissue itself which causes this condition. On the other hand, the heavy leaden bullet, the smooth-walled pointed needle, or other similar objects, which, as a rule, are found lying in cysts, may be firmly impacted in the bone, or in a similar, but little movable tissue, without any kind of cyst-formation being perceivable.

Therapeutic deductions from these observations.

If we wish to draw practical conclusions from the preceding observations, we may from the contemplation, especially of the erosion caused by bullets and needles in cystic cavities, in regard to the possibility of an erosion of blood-vessels or of the intestines, be convinced of the necessity for extirpation of these foreign bodies under all circumstances, even in the absence of any kind of objective signs of irritation,—of course only in regions of the body where this danger is imminent.

Apart from similar, so to say, defensive conclusions, however, we ought to weigh in our mind whether we may not take advantage of this kind of experience of healing-in of foreign bodies for therapeutic purposes.

The successful experiments in the healing-in of foreign bodies have been ever since the introduction of the antiseptic method, and evidently only through this, on the increase, whilst formerly foreign bodies were exclusively employed only as unfailing exciters of suppuration (setons), or, at the most, in order to produce a cicatricial canal (lead-wire in webbing of the fingers). Now-a-days silk, catgut, decalcified bone, elastic ligatures, wire, steel nails, jodoform gauze (*Winiwarter*), and even fluids, as blood and jodoform-glycerine and other substances, are employed for healing-in.

The healing-in of these substances has only partly in view their persistent action as ligature, suture (*Lister's* silver-wire suture of the patella), local irritation (ivory-pegs in the broken ends of the bone), tampon, &c. The healing-in is here only a more or less unpleasant necessity in order to bring about in deep-seated injuries, in spite of the introduced foreign body, a definite, complete union by first intention of the skin or soft parts, and thus to shorten the duration of the cure.

The experience that heavy foreign bodies, leaden bullets, in moving parts of the body, and in soft tissues, are found in cystic spaces, in capsules of connective tissue, moreover, older and personal observations on the mode of healing-in of smooth (pointed, sharp-edged) pieces of glass, lead to the conviction that by a similar process of healing-in, artificial cavities might be produced which would be of great importance for securing a cavity after resection in the joints, especially for the establishment of artificial joints, and which, moreover, would probably be of value in regions of the body in which, according to experience, cicatricial traction is fraught with danger, as in serous cavities, in articulations, in the sheath of tendons, and in the meningeal space. For the latter especially the employment of glass-plates for the protection of the adherent brain-cicatrices seems to be not a hopeless proceeding.

We have succeeded in producing in animals the wished-for result of the formation of pseudo-arthroses. In man a similar effect was attempted in a case of resection of the elbow; several layers of gutta-percha tissue were placed between the smoothly sawn-off surfaces of the bones, with the view of preventing, by the temporary insertion of a smooth foreign body, the primary union of the wounds of the bones. When, however, after a fortnight the foreign body was removed, the result appeared by no means quite satisfactory. There was no osseous anchylosis, but the mobility was slight. It would certainly be better to permit a suitably-shaped larger glass piece to heal-in perfectly, or, at least, to remove it after a longer lapse of time. Every one who possesses practical experience will feel the desirability of the improvement of our present methods for the establishment of artificial articulations and the prevention of anchylosis. Did not a past master in resection like *Ollier* report only last year that he was obliged in one case to operate three times in the elbow in order to obtain finally a movable joint?

I recently tried to prevent, by insertion of gutta-percha in a secondary suture of the tendons, the union between the tendinous and cutaneous cicatrices, on the final results of which experiment I shall report later on. The twice-repeated attempt to replace the defect of the cranium and the dura mater by glass failed in consequence of the animals experimented on (cats) having soon after died of mange. These experiments will be repeated, but their good result is already anticipated by the favourable observations on tissue-alteration produced by glass in other parts of the body, and, on the other hand, by the successful healing-in of india-rubber plates in defects from trephining (*Lesser*).* Successful trials have been instituted by *Stern* to prevent adhesions in the abdominal cavity by means of collodium. It is only questionable whether this kind of proceeding as regards the peritoneal cavity will find practical advocates, as the unfavourable results caused by the formation of adhesions after laparotomy are in reality very exceptional.

Apart from the healing-in of glass in view of the formation of cavities, this might certainly also be employed as an innocuous material, especially in the form of glass-wool, for filling up defects of bone; *e.g.*, after operations for necrosis, after the removal of tuberculous foci, or as supports in the form of round pieces of glass for filling up the spaces left by the removal of the metatarsal or metacarpal bones. In animals the glass-wool, employed as a substitute for the resected femoral condyle, answered the purpose, a normally movable healthy knee-joint having been produced.

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* *Note by the Translator.—Dr. von Eiselsberg*, Lecturer on Surgery at the Vienna University, recently (May 28th, 1891) demonstrated before the Society of Physicians of Vienna two cases in which defects of the cranial bones had been successfully replaced by the healing-in of celluloid plates. In one of these, a case of caries, the diseased bone was removed, and a plate was substituted with complete success. In the second case there was a cicatrix and depression of the frontal bone from the kick of a horse, which had caused epileptic fits. The cicatrix of the bone was removed by trephining, and the defect remedied by the healing-in of such a plate, with a technically perfect success, though there is no security against the return of the fits.—D. J. v. L.

For filling up cavities in bones *Winiwarter* employed jodoform-gauze, and *N. Senn* decalcified bone-shavings; for a similar purpose, as filling material, *Schede* used blood, and *Billroth* employed jodoform-glycerine, both successfully — jodoform-glycerine principally owing to its antiseptic action. On the other hand, blood and other kinds of absorbable substances are, of course, not to be used as supports for thin shells of bone, as would be desirable in caries, *e.g.*, of the calcaneum, and, of course, also not as substitutes for the extirpated bone. Only ivory has hitherto, as far as I know, been used for supports. *Professor Rose*, of Berlin, showed me two years ago a patient in whom the shaft of the tibia had been replaced by an ivory rod.

I have been led by manifold considerations to a future employment of glass in the form of glass-wool.

Porous, fibrous materials, silk, gauze, as a rule, heal-in by being permeated by connective tissue, in such manner that they finally grow into a more or less firm cicatrix. A similar result was to be anticipated from the glass-wool. The production of firm resistent tissue, *i.e.*, cicatrices, is the aim of all the so-called radical operations for hernia. I, therefore, two years ago, introduced glass-wool into the aperture of a crural hernia, in order to produce, by means of an inabsorbable material, consisting of delicate fibres, a persistent cicatrix.

Seven years ago I tried *Schwalbe's* method of injecting alcohol in inguinal hernia, in a greater number of cases, both in *Professor Billroth's* clinic and in the out-door patient department. The immediate results were very satisfactory; callous shrivelling of the hernial opening took place (never accompanied by any unfavourable incidents), although the final result must be considered as perfectly unsatisfactory, as the callosity and the constriction of the hernial opening had in every case disappeared in a few months, and the hernia, consequently, had formed again. In two cases, afterwards, the production of induration in the hernial opening was attempted by keeping up, after the ligature of the hernial sac, granulation for many weeks by the application of jodoform-gauze, a proceeding which proved so successful that a very strong cicatrix actually formed, which, after twelve months, had become so very delicate as to permit the skin to be taken up in folds over the deeper layers.

As it is well known, in *Czerny's* method for the radical operation for hernia, it is intended to produce a resistent cicatrix by burying the silk ligatures applied to the ring of the inguinal canal. *Professor Billroth*, for this reason, always employs for the sutures very thick silk threads, like those used for the sutures of the fascia after laparotomy. I repeatedly convinced myself that in these cases, although a very violent inflammatory reaction had been set up, after a year or so *no continuous induration around the silk threads could be discovered, at the utmost only small nodules.* Although *Czerny's* operation for the inguinal hernia may frequently have a radical effect, the hernial sac having been tied and the hernial opening thus having been directly closed up, on the other hand, in crural hernia, the difficulty of sewing up the hernial opening suggests the trial of another method.

I tried *glass-wool* in the following case (*Clinical Case Book No.* 147, *of the year* 1887): M. S., a maid-servant, thirty years of age, suffering for ten years from a crural hernia at the left side, produced by lifting a heavy weight. It was small at the beginning, nor did it cause any inconvenience or pain until six years ago it had suddenly reached the size of an apple, when it became irreducible, and brought on symptoms of incarceration. Herniotomy was performed at *Professor von Dumreicher's* clinic, and the patient was discharged with a truss three weeks after the operation. The truss broke (?) a few hours after her discharge, and the hernia reappeared on the same day in its former size (?). Notwithstanding her hard work, however, the patient felt no kind of inconvenience from the progressive enlargement of the hernial tumour until on the 2nd of May, 1887, the hernia suddenly assumed the size of a child's head, and repeated vomiting and obstruction of the bowels took place. These symptoms, however, soon ceased. The patient, owing to the size of the hernial tumour, decided to submit to the radical treatment.

Condition of the patient: A middle-sized, thin, delicate woman. In front, at the apex of the lungs, sharp, rough vesicular respiratory sounds; otherwise, nothing abnormal in the internal organs. In the left crural region a soft elastic tumour of *the size of a child's head*, giving on percussion a tympanitic sound. The integument above it, showing numerous lineæ albicantes from former pregnancies, is so thin as to permit the intestinal coils to be distinctly felt. The reposition of the hernial contents was easily effected. The hernial opening, formed by a hard ring, admits three fingers.

On *May 17th*, 1887, the radical operation for hernia was performed under anæsthesia. After the reposition of the hernia, the now emptied hernial sac was excised by eliptical incisions. On opening the hernial sac, which had been freely exposed during the operation, an adherent omental band was tied and divided by means of the thermo-cautery. The neck of the hernial sac was secured by a kind of purse-string suture, and the hernial sac separated and divided by *Paquelin's* cautery. The remainder of the hernial sac was stitched to the hernial ring, plugged with jodoform-gauze, and the greater part of the cutaneous wound united by interrupted silk sutures; jodoform-gauze, carbolic-gauze dressing. Four days after, the dressing, which had been soiled by the menstrual secretion, was removed. The strips of jodoform-gauze were pulled out from the wound, and replaced by *sterilised glass-wool*, which was done that it might heal-in and produce a solid closure of the hernial opening. On changing the dressing on June 1st, the suture line was so firmly united that the stitches could be removed; the as yet ununited portion of the wound was granulating. The glass-wool healed-in most successfully; its protruding fibres were removed.

The patient left her bed with a truss (with a concave pad), on June 15th, and the wound was completely cicatrised on June 27th, when the patient was discharged.

She died of tuberculosis, in the General Hospital at *Wiener Neustadt*, on September 22nd, 1888.

Regarding an examination at a shorter period after the operation as premature, I intended to summon the patient to *Vienna* after twelve months, but, to my regret, I could not find her residence, and was subsequently informed of her death by the provincial authorities. Neither the medical officers of the Hospital at *Wiener Neustadt*, nor the patient's own relations, knew of the existence of a hernia. I therefore mention this case merely as an instance of an attempt to employ glass-wool for the radical cure of a relapsing, exceptionally large crural hernia, without, however, being able to report positively as to the final result.

Thiem, acting on the suggestion of *Gluck*, recently allowed a bundle of *catgut* to heal-in in the opening of an inguinal hernia, endeavouring thus to bring about the formation of induration in the hernial opening, viz., to effect the radical cure of the hernia. Probably the secondary pathological tissue-formation, the resistant cicatrix, will also disappear at the same time with the absorption of this tampon, as we have seen take place after injecting alcohol. And *Thiem* actually reports that half a year after his first, the oldest, radical operation, the cicatrix was apparently considerably thinner.*

The pieces of fresh bone employed for filling-in the defects in bones cannot be regarded as carrying out the views of *MacEwen* and *Adamkiewicz*.

By the use of absorbable tampons, as in hæmatoma, the firm union of the surrounding tissue may be prevented, and on the other hand the reactive alteration of the soft parts of the organised infiltrate may be transient.

It may, however, appear hazardous to enclose larger and heavy foreign bodies in the organism, on account of the danger of subsequent suppuration. *Billroth*, twenty years ago, directed particular attention to the frequent formation of abscesses around bullets, which had long lodged without any reaction, or healed-in. The late setting in of suppuration in these traumatic cases may, apart from other possibilities, in most instances be explained on the supposition that *splintered, rough* bullets, or pieces of metal, by energetic movements of the injured individual, subsequently cause hæmorrhage in the surrounding tissue, especially if they had reached the surface of the body, in consequence of frequent injuries. Again, suppuration may be induced in these hæmatomas by cocci temporarily circulating in the blood. It seems to me unquestionable that the physical condition of the enclosed foreign body is therefore of the greatest importance, though *Dementiew*, in contradiction to *Billroth*, doubts it. A rounded piece of glass will, in the above sense, be less fraught with danger than a splintered leaden bullet. Moreover, by the excision after many months of the foreign body, introduced for the purpose of forming a cyst, we ought not to sacrifice the result aimed at, as French authors have pointed out, as regards large hæmatomas, that a pathological tissue-cavity may persist notwithstanding the disappearance of the effused blood in the course of time.

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* The absorbable tampon has been more frequently proposed in recent times. Besides the older suggestion of *Gluck*, to use catgut, the Americans especially have invented various methods, viz., *N. Senn*, decalcified discs of bone hardened in alcohol, and *Dr. Halstead* at the New Hospital at *Baltimore*, demonstrated to me in the course of this year a material for tampons, consisting of delicate threads prepared from the submucous membrane of the pig, and likewise sterilised in alcohol. I have convinced myself of the absorption of this material within two months and a half, in the abdominal cavity of a rabbit, without causing any perceptible reaction. But I have not yet had an opportunity of employing it, notwithstanding the very rich material of the clinic.

In England for arresting hæmorrhage in uranoplastic operations, and in bleeding from the descending palatine artery, in the canal of the bone, carbolised or sublimated wax is employed, which is plugged into the canal, where it may heal-in. But this method of arresting hæmorrhage may be dispensed with.

Albeit the expectations as to the suitableness of glass above described may not be realised in every respect, still the accurate description of the results arrived at by the healing-in of foreign bodies may encourage to successful experiments.

The review of the anatomical observations on chemically indifferent, not readily soluble, heavy foreign bodies, shows that (1) *if of but slight weight and circumference, and in perfect rest, they will readily heal-in in cicatricial tissue, provided they are porous, fibrous, or rough; they, therefore, may be suitable for the production of indurations.*

(2) *Foreign bodies of moderate weight and more compact consistence, if smooth-walled, heal-in into capsules of delicate connective tissue; if the surface be porous and rough, the capsule will be denser, the cicatrix firmer; these kinds of foreign bodies may, therefore, serve as suitable supports in soft parts or in bone.*

(3) *High specific weight, presenting everywhere a smooth surface, sharp edges or points, are conditions of a foreign body which render probable its healing-in in capsules of connective tissue containing fluids; the more so, if the injured part be not at rest. Such foreign bodies may prove particularly suitable for the prevention of adhesions in wounded parts, and likewise for the formation of pseudo-arthrosis.*

VIENNA, *December*, 1889.

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Plate I.

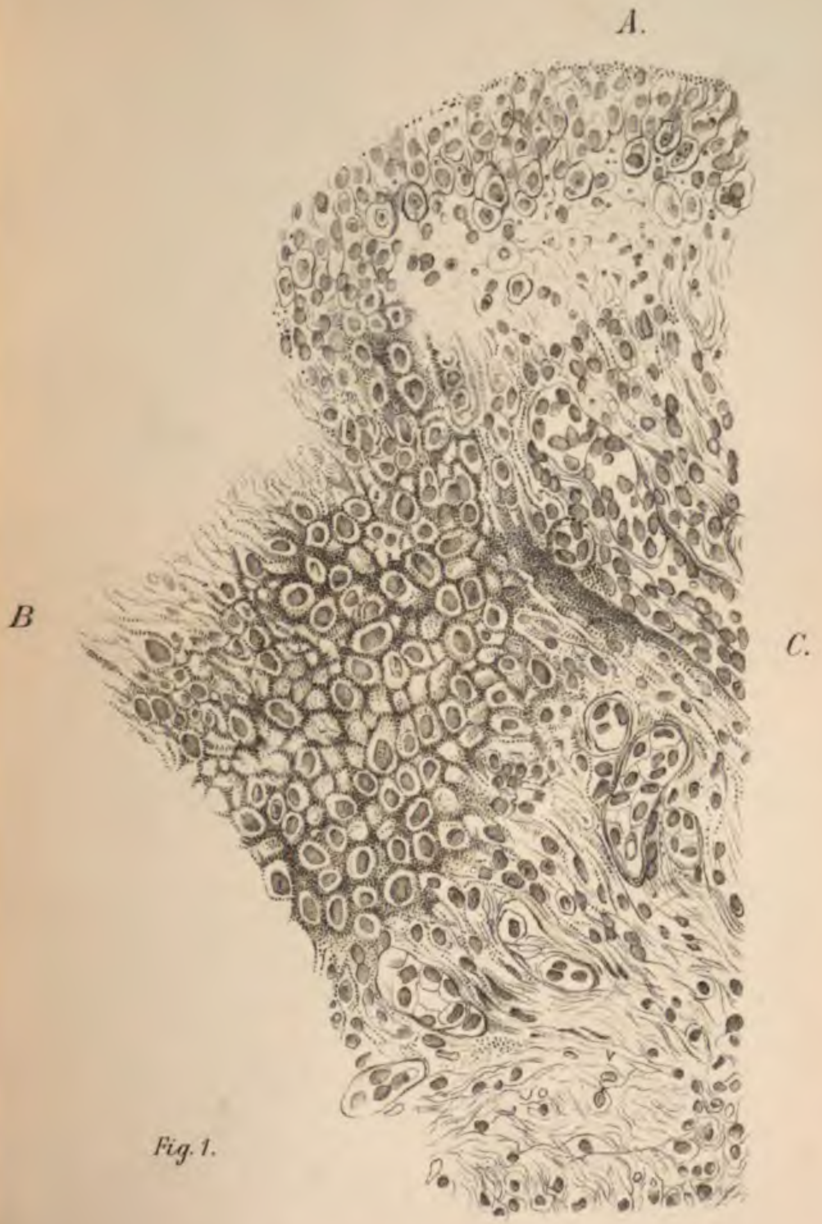

Fig. 1.

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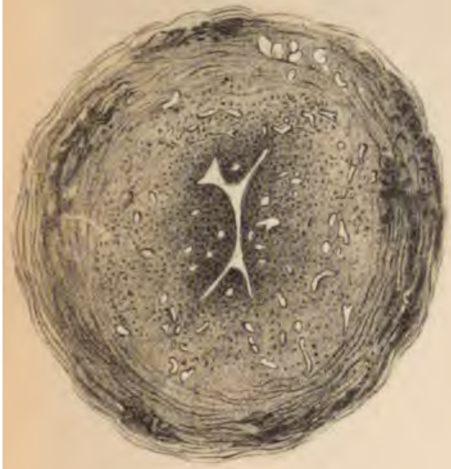

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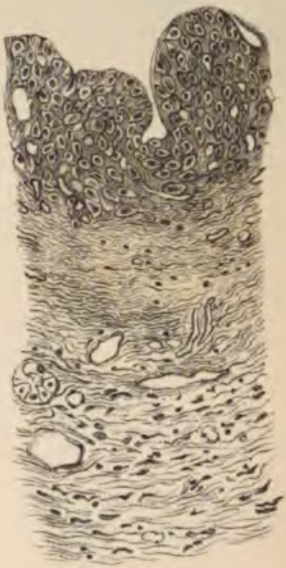

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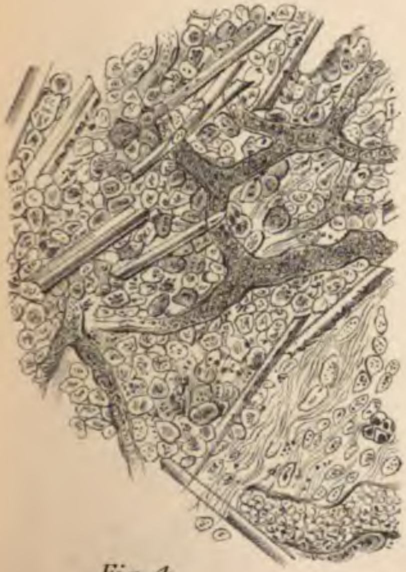

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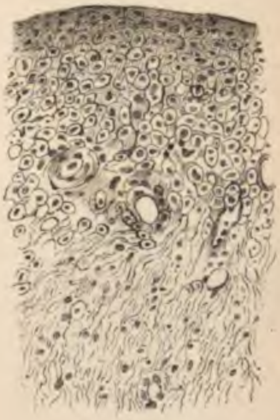

Fig. 5.

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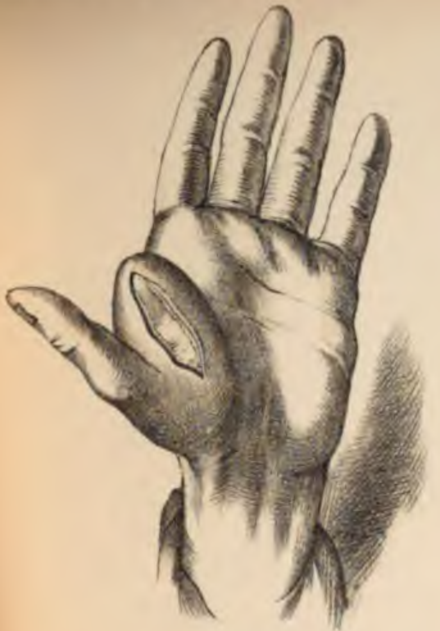

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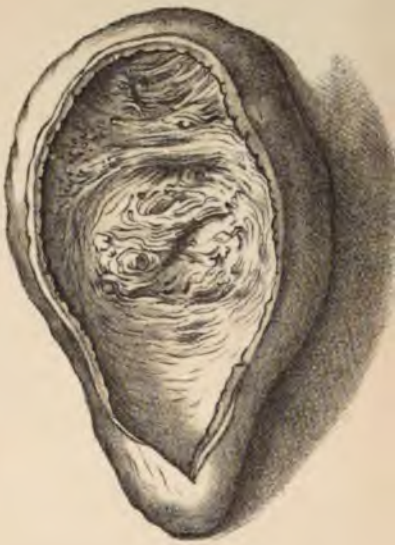

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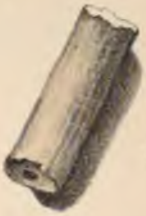

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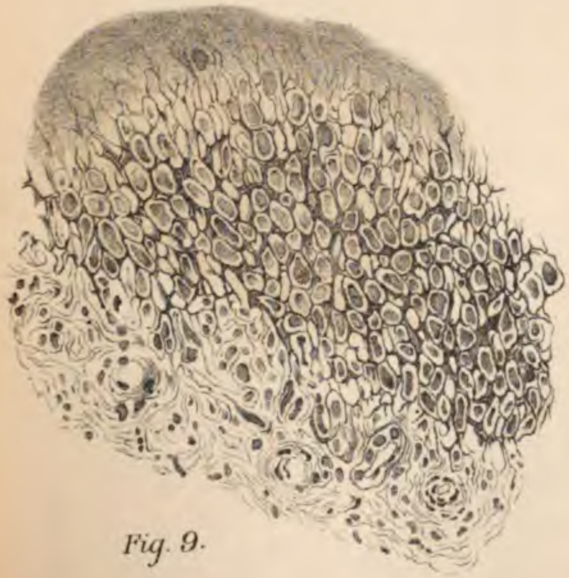
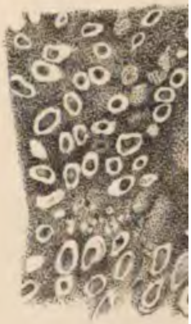


Fig. 9.



Alfred Holder, k.u.k. Hof-u. Universitäts-Buchhändler in Wien.

DIABETES MELLITUS.

BY

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alimentaris, D. intoxicativus, &c. But it soon appeared that all these forms of sugar excretion, whether artificially produced or connected with other pathological conditions, have nothing whatever to do with Diabetes proper—a disease *sui generis*—and differ from it essentially in three important points.

I. They are merely transient, they disappear after the cessation of the disease that produced them, or shortly after the healing of the injury that caused them.

II. They are quite independent of the nature of the food administered.

III. They cause none of that profound disturbance of the general health which as a rule accompanies true Diabetes.

In order to distinguish these forms of sugar excretion from Diabetes mellitus, the name Glycosuria is now generally applied to them.

Under Diabetes mellitus (sugar-flux), or Diabetes gravis, we understand therefore only that slowly developing afebrile chronic disease in which grape sugar, varying in quantity with the amount of carbo-hydrates ingested, is constantly present in the urine, and in which the general health suffers very seriously from the nutritive disturbances in the various organs of the body. Although my object is only to deal with this disease, and ignore all other forms of Glycosuria, I must mention two forms of sugar excretion experimentally produced. These have recently been discovered, are in many respects of great interest, and possibly destined to throw a ray of light into the obscure pathology of the disease. The first form was communicated by Mering of Strassburg, three years ago. Mering gave a dog after seven days' fasting, whose body consisted simply of albumen and fat, and was therefore free from carbo-hydrates, a daily dose of 20 grams (about 300 grs.) of Phloridzin, a glucoside contained in the cortex of the root of the apple-tree. As a result a large amount of sugar, from 10 to 19 per cent., was excreted. This form of glycosuria differs from other artificially produced forms, as also from Diabetes verus, in that the normal quantity of sugar in the blood is diminished. But as the continuous administration of Phloridzin does not produce a permanent excretion of sugar, it must be regarded as a form of glycosuria rather than diabetes. However, this experiment would seem to prove the assertion of later investigators (notably

Seegen) that sugar is, or at any rate may be, formed out of albumen and fat.

The second form results from experiments by Mering and Minkovski, who excised the pancreas. Immediately after the operation sugar appeared in the urine and persisted for weeks until the death of the animal. Simultaneously, other leading features of Diabetes are said to have been present: Polyuria, Polydipsia, insatiable hunger, and great emaciation in spite of abundant nutriment. Glycogen disappeared from the organs, sugar was largely increased in the blood, and a considerable quantity of acetone found in the urine. These experimenters state that the solar ganglion was not injured during the operation, and therefore the Diabetes is to be considered as a pure consequence of the arrest of the functions of the pancreas. They look upon the secretion of the Pancreas—Trypsin—as the most powerful diastatic ferment, and that which alone effects the conversion of maltose, formed during digestion from carbohydrates, into grape sugar. Their statements are confirmed by Lépine, who performed antiseptically excision of the pancreas without injuring the Solar Plexus, and obtained similar results. Further researches in this direction should throw some light upon the still obscure data of Diabetes.

HISTORY AND THEORIES OF DIABETES MELLITUS.

The various theories of Diabetes are intimately connected with the history of the disease. Although it is beyond doubt that physicians of old were well aware that in rare cases sweet-tasting urine was excreted, yet this phenomenon was not considered worthy of any particular attention, and indeed it is still uncertain whether the ancients meant to indicate "sugar-flux" by diabetes or simple polyuria, now termed Diabetes insipidus. To Thomas Willis, an Englishman, is due the merit of being the first (in 1674) to describe and recognise Diabetes as a disease, with sugar in the urine as its chief symptom. Still, it was not until 100 years later, after Dobson and Pole had succeeded in demonstrating directly sugar in the urine, and John Rollo had confirmed the injurious influence of starchy foods in the course of Diabetes, thus directing treatment into the right path, that physicians really began to take a closer interest in this disease. Its symptoms were thoroughly noted, and valuable experience in ætiology as well as in therapeusis was gained, but the pathology of the disease remained veiled in complete obscurity. All the theories that have been advanced from that time to the middle of the present century rested on purely hypothetical grounds. Every one of them started from the supposition that carbo-hydrates of the food were abnormally speedily converted into sugar by means of some ferment (Bouchardat), or that the normal quantity of sugar was less rapidly consumed owing to diminished alkalinity of the blood (Mialhe). Not only was there then, as now, no anatomical ground for these theories, but also no scientific basis in the absence of information concerning the origin and consumption of sugar in the animal economy. The enumeration of all these theories, and of the names of their propounders, has but a historic value, and cannot be given within the limits of this article. The researches of Claude Bernard are the first to bear a scientific character, as set forth in his fundamental treatises: "The Formation of Sugar in the Liver, 1848"; "Glycogen found in the Liver, 1850"; "Artificial Excretion of Sugar by means of puncture of the floor of the fourth ventricle, 1854."

C. Schmidt and Thompson had already demonstrated that sugar is a normal constituent of the blood, though this was not definitely ascertained to be grape sugar till 1875 by Abeles. At the outset an exact determination of the amount in the blood was surrounded with difficulties. No chemical method was known by which sugar could be isolated from the blood owing to the albumens having a disturbing influence in the reduction of the copper (Fehling's test). It was not until Schmidt-Mülheim published their method of eliminating the albumens that the statements of workers came into general agreement. The physiological amount of sugar present in the blood varies from ·08—·15 per cent. These variations are due to the quality and quantity of food, to the time when taken, to the condition of the muscles, and to other factors of which we know but little.

The most important questions then to solve, were, I. Where is the seat of the manufacture of sugar? II. What are its antecedents? III. What nervous influence is at work during the formation of sugar? Claude Bernard answered these questions categorically. He maintained that the liver is exclusively the seat of the formation of sugar, as is proved, first, because the liver itself contains sugar; second, because the blood in the hepatic veins contains more sugar than that in the portal system, which scarcely shows a trace. Bernard, therefore, inferred that sugar formed in the hepatic cells, passed along the hepatic veins into the inferior vena cava to the right side of the heart, and reached the pulmonary circulation, where the greater portion underwent oxidation, and the rest was distributed through the arterial system.

The second question, What is the source of the sugar? Claude Bernard believed he had solved completely, when he and Hensen succeeded in discovering a substance in the liver which bore a strong relationship to sugar. He regarded this substance, which he found only in the liver and nowhere else, as the material from which the liver prepares the sugar by means of an (animal) ferment, likewise present, and he consequently termed it glycogen (sugar-generating). Finally, he believed he had demonstrated by "the diabetic puncture" that the nerve centre regulating the formation of sugar has its site in the floor of the fourth ventricle.

These statements of Bernard, which prevailed for several years, were much shaken by control experiments, and by the more extensive researches of succeeding physiologists. In the first place the English physician Pavy, in 1860, confirmed the statement of Bernard, that sugar could be obtained from the liver of an animal recently killed, which increased in quantity the later the examination was deferred after the death of the animal. On the other hand he soon arrived at the conviction that the blood of the hepatic veins did not differ as regards the amount of sugar from that of other blood-vessels. Further, that the slight increase of sugar in the liver was due to the struggles of the animal during the removal of the organ, which was forthwith placed in boiling water so as to destroy any ferment or post-mortem influence.

Still Pavy believed that, although under physiological conditions exceedingly slight traces of sugar circulate in the blood, the excess in the blood of diabetics originates in the liver. In fact, by stating that the circulating blood contains a ferment capable of converting hepatic glycogen into sugar, he thus placed his views in accordance with the correct theory of diabetes. Through nerve-influence the efficacy of the ferment is inhibited; should this influence fail, as after death, or become weakened, as in diabetes, a continuous formation of sugar takes place in the liver, the blood becomes surcharged with sugar, and the urine carries off the excess. Shortly after this, glycogen was found to exist in other organs of the body besides the liver, in the lungs, spleen, kidneys, cartilage, leucocytes, and particularly in all striated muscular tissue. In consequence Pavy's theory was modified to include all the above-mentioned organs as sources of origin for the formation of sugar. This modified theory held sway for nearly twenty years: under physiological conditions, no formation of sugar in the liver and only slight traces in the blood, in diabetes all glycogen-bearing organs become sources of sugar.

In 1875 Seegen, who up till then accepted the above theory, discovered that sugar formed from glycogen with the help of animal ferments (saliva, pancreatic juice) is not grape sugar, but one of less reducing power (Maltose, Ptyalose, Pancreatose, &c.), whereas hepatic sugar undoubtedly is grape sugar. Thence he concluded that hepatic sugar could not be formed through a ferment; he denied, moreover, the existence of the latter, as he had not succeeded in isolating it. Furthermore, he found by his experiments, without exception, ·4 to ·5 per cent. of sugar in the liver. This amount increases considerably after death, owing to the continued activity of the hepatic tissue, but the amount of glycogen actually remains the same. Seegen consequently deduces that hepatic sugar is not formed from glycogen but from some other material.

As a result Seegen restored to a great extent the doctrine of Bernard as regards the seat of sugar formation in the liver, and confirmed it through the repetition of the fundamental experiment of Bernard, *i.e.*, comparing the blood from the distal with that from the proximal hepatic venous system, by means of a very perfect technical method. He was able to withdraw blood direct from the hepatic veins (not from the vena cava, where the blood is already mixed), and prove that without exception the quantity of sugar contained was nearly double that in the portal blood—on the average ·230 per cent. in hepatic blood, as against ·119 per cent. in portal blood. Having at the same time determined how much blood flows during a given time through the portal system into the liver, he calculated the quantity of sugar formed during 24 hours in the liver, and conveyed thence to the tissues. In an animal weighing 40 kilograms, he found the surprising amount of 433 grms. of sugar. In order to keep so great an amount of sugar in equilibrium in the body a very large proportion of carbo-hydrate material must be used up for the formation of sugar, and consequently this must be one of the most important functions of metabolism.

As regards the use of sugar in the body, Seegen believes that it serves for the generation of heat and energy. As to what is the origin of the sugar, as already mentioned, he takes up quite an opposite standpoint to Bernard. He maintains sugar is not formed in the liver from glycogen, but from albumen (Pepton) and fat, although no one has succeeded in obtaining it chemically from albuminous substances outside the body. He supports his statements by a series of feeding experiments on animals. His conclusions are—

First. That the carbo-hydrates of the food are converted in the liver into glycogen, which is thence carried by the blood-stream to the muscles, lungs, cartilages, &c., and deposited there.

Second. That glycogen is in all probability the material for fat formation, and is stored up in the body with that object. In fasting, glycogen disappears, and, indirectly owing to failure of supply, so does the fat.

When the hepatic cells lose their function of converting sugar, already formed in the alimentary canal during digestion and brought by the portal system to the liver, into glycogen, so that it reaches the general circulation, and is, to a certain extent, excreted in the urine, then the slight form of Diabetes is said to exist, in which, namely, the excretion of sugar ceases as soon as the sugar-forming element in the nutriment is curtailed.

If, however, the organism fails to consume the sugar normally formed from albumen and fat (in the process of metabolism), the grave form of Diabetes arises, where sugar is excreted even with an exclusive meat diet. The ætiological factor in both forms lies in the nervous system.

Seegen's theory, which, to a large extent, rests on speculation, has experienced several attacks, and the disputes concerning it are still far from settled. The blood of Diabetics has been examined by Seegen and others, who found it contains nearly twice the normal quantity of sugar. According to the severity of the case, the condition of the patient at the time, and the hour of the examination, the amount varies from ·15 to ·33 per cent. (Frerichs ·28 to ·43 per cent.). The other organs contain approximately as much, Liver, Brain, Lungs, Spleen, &c., besides lymph secretions, pathological exudations, and the cerebro-spinal fluid. Owing to its extreme diffusibility, whenever there is an excess of sugar in the blood, it makes its way into the various tissues and fluids of the body.

Naturally, in connection with this fact, the question arises, Is the abnormal quantity of sugar due to an increased production, or the result of the non-consumption of the normal amount, part of which is stored up and part excreted in the urine?

This is still a matter of controversy, and will remain so as long as obscurity reigns over the cause and intimate processes of sugar formation, and over the part played by sugar in the animal economy. The fact remains that the circulating blood is only capable of harbouring normally a certain quantity, should this be exceeded, the excess is carried off by the kidneys. In grave cases of Diabetes, sugar taken as nutriment appears in the shortest interval in 30 minutes in the urine, and is entirely excreted within 1½ to 2 hours.

Passing over a number of ingeniously worked out hypotheses which have not withstood the test of time, I should like to draw attention to the views of two distinguished men upon increased sugar formation—Senator, of Berlin; and Ebstein, of Göttingen.

Senator shows, that without excluding other possibilities, in the majority of cases two causal conditions are the most probable.

I. The sugar in the food passes into the lacteals and portal system* in a larger than normal quantity, either because its conversion into lactic acid is prevented, or because it is too speedily absorbed.

II. The portal circulation is accelerated abnormally; hence, on the one hand, more sugar reaches the liver and passes on into the systemic circulation without undergoing change into glycogen, on the other hand hepatic glycogen is more rapidly converted into sugar and carried away. The first source depends on the nervous system, the second on a local disturbance in the intestinal and hepatic circulation. Consequently, Senator distinguishes a neurogenic, a gastro-enterogenic and a hepatogenic form of Diabetes.

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* According to latest researches the greater part reaches the portal vein, and only a small fraction the lacteals.

Ebstein's theory refers the origin of the disease to the protoplasm of the cells of most of the organs and tissues. In Diabetics, through abnormal nerve-influence, protoplasm has lost the property of producing as much carbonic acid from an equal quantity of carbohydrates as in healthy persons. Ebstein says he has found by experiment that the action of diastatic ferments is impeded by the presence of a certain amount of carbonic acid. In diabetics, owing to deficiency of carbonic acid, carbohydrate material, especially glycogen, is insufficiently protected from their influence, and is consequently converted prematurely and in relatively large quantities, into easily diffusible carbohydrates, particularly sugar, and this passing from the tissues into the circulation is rapidly excreted with the urine. Furthermore, owing to diminished oxidation and formation of carbonic acid, the need of oxygen in diabetes is decreased, and consequently the bodily temperature is lowered.* On this view Ebstein proposes to administer carbonic acid constantly, viz., by means of injection into the rectum. How far this theory is justified depends on further researches in this direction. I will now return to those investigators who regard a diminished consumption rather than an increased formation of sugar as the proximate cause of diabetes, such as the majority of recent writers, and also Mering and Minkovski, whose very important experiments were mentioned at the outset.

Should it be settled beyond cavil that after excision of the pancreas either with or without injury to the coeliac plexus, not only artificial glycosuria occurs constantly, with perhaps a small quantity of sugar and of transient duration, but also genuine diabetes with its cardinal symptoms: persistent excretion of sugar in great abundance, intolerance of carbohydrates, progressive proteid waste and abnormal amount of sugar in the blood, then considerable strides will have been made towards the knowledge of a disease still enshrouded in mystery.

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* Voit and Pettenkofer have found by direct analysis that diabetics consume less oxygen and exhale less carbonic acid and watery vapour.

Here we should also mention a very recent experiment, where, after removal of the cœliac plexus, acetonuria is a constant result.

PATHOLOGICAL ANATOMY AND ÆTIOLOGY.

Pathological Anatomy, as a rule the safest guide in the search for the seat and origin of disease, leaves us completely in the lurch. Tissue changes are from time to time noted, amidst numerous negative results, in one or other organ, but constant changes in any particular organ have never been observed. Neither in the central nervous system (brain, spinal cord) to which the origin of diabetes has been ascribed, nor in the liver, which we suppose to be the seat of sugar formation, nor in the pancreas, where atrophy, fatty degeneration, or cancerous infiltration occur relatively frequently, nor in the kidneys, nor even in the organs of respiration or circulation—in short, nowhere are we in a position to show a constant abnormal condition.

It would, therefore, be idle to enumerate all the anatomical changes which occur now and again in diabetes, as it is not known with certainty whether these in isolated cases bear a causal relation to the disease or are simply coincidences.

The glycogenic degeneration of Henle's loops in the kidney discovered by Ehrlich, which had previously been described by Ebstein as necrosis of the epithelium, is most worthy of note. At any rate, this change is one of the most frequent.

The only method of determining post mortem the diagnosis of diabetes would be by examination of the blood, which, if it contained twice the normal amount of sugar, would prove the case to be one of diabetes. Unfortunately, up to the present comparative analyses of the blood before and after death, in diabetics, as also in healthy individuals, have been made too seldom to render conclusions trustworthy. Where the pathological anatomy of a disease is not yet known, its ætiology as a rule is not in a much better plight. It has not yet been settled definitely, whether diabetes can arise suddenly from any given cause. In the majority of cases, it develops very gradually, and as the beginning is not accompanied by any pain or striking malaise, the exact starting point of the affection is rarely ascertainable. Where the patient is inclined to date the commencement of his illness from some external cause, *e.g.*, severe shock to the nerves, thorough drenching, serious injury, &c., it is much more likely that the disease, already in existence, has suddenly been aggravated, just as we observe in the more advanced stages of diabetes that a severe shock may suddenly increase the amount of sugar by 2 or 3 per cent. Nevertheless there are always circumstances and conditions, as manifold experience shows, which can be regarded as predisposing factors.

1. Hereditary Influence. The disease may pass from either parent to one, two, or all the children, sometimes from the grand and great-grand parents. Frequently it is confined only to a side branch. Such families generally show a neurotic taint. As regards age, it was thought formerly that children were not attacked, now the number of observations of diabetes in children of tender age increases with every year. Even extreme old age does not enjoy immunity. The greatest number of cases occur between the ages of 30 and 50. The age of diabetics has always an important bearing on prognosis (*v.* prognosis).

As regards sex, it is remarkable that twice as many males as females become diabetic; in children the reverse is said to hold good (3 to 5). The reason for this is unknown, as also whether Diabetes mellitus is infective. No bacillus diabeticus, or its toxic products, has been hitherto discovered. At the same time, it is worth mentioning that, of 200 cases carefully noted by myself during the last ten years, I find four married couples, in which the wife first suffered from diabetes, and the husband from 3 to 5 years later. In all four cases no common cause could be ascertained.*

2. Psychical disturbances, not so often the transient, *e.g.*, fright, anger, vexation, as the long persistent and deep-seated, *e.g.*, grief, care, bereavement, melancholy, &c. It is easily understood that when there is hereditary predisposition to neurosis, the tendency is all the stronger. All conditions arising from nervous exhaustion, *e.g.*, neurasthenia, sluggish convalescence after serious illness, mental strain, especially connected with the emotions, sexual excess, &c., must be also included.

3. Obesity arising from luxurious living and sedentary habits is decidedly a predisposing factor. The percentage of obese

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* De Bove and Lecorché also mention some cases of conjugal diabetes.

individuals in diabetes is so considerable that Hoffmann in fact divides diabetics into two groups, according to their symptoms.

I. The neurogenous or accidental, due to injuries of, and changes in the nerves; this group is chiefly seen in males. Furunculosis is almost never present, albuminuria and cataract exceedingly rare, and the pancreas is at times atrophied. With the cure of the nerve affection, diabetes disappears (slight form).

II. Diabetes of the obese, or constitutional diabetes, more frequent in women, tendency to furunculosis and cataract, often complicated by gout and nephritis (severe form).

4. Injuries, especially after concussion of the brain, spinal cord, and abdominal ganglia, with subsequent glycosuria and Diabetes insipidus, particularly if for any reason the latter persist for a long period.

5. Irritation of the female generative organs, according to Imlach, may produce diabetes. He published a striking case where, after removal of some extensive uterine adhesion, diabetes of long standing completely disappeared (Glycosuria ?) For this reason diabetes is stated to occur not only less frequently and in a milder form after the climacteric period, but also to run a more favourable course.

6. The excessive use of saccharine and amylaceous food-stuffs may be a predisposing factor. I had opportunities of convincing myself of this in some cases in which no other detrimental factor could possibly be adduced.

Lastly, diabetes has been noticed to occur in a number of different diseases: in ague, epilepsy, alcoholism, syphilis, &c. But it would indeed be an error to conclude that *post hoc propter hoc.* If the above diseases, which are widespread enough in all classes of patients, did render the ground suitable for the production of diabetes, this would certainly figure in their statistics, but in spite of the remarkable increase of diabetes during the last decades we know that this is not the case. It is very difficult to determine whether the cause of this increase is due to the simultaneous increase in insanity, or to the more burdensome conditions of modern life involving trouble, care, mental and bodily strain, or else to circumstances which still elude observation. Carefully compiled statistics, embracing towns and villages in various countries, would best help us to a conclusion on these points; but so far these are wanting.

SYMPTOMS.

The first disturbance of health the patient experiences is generally so trifling, and connected with so little discomfort, that it is either ignored by him or misinterpreted by his physician. Even should the latter consider it necessary to examine the urine, the small quantity of sugar that may be present is easily overlooked in employing the usual tests (Heller's or Trommer's). It is only when symptoms persist in spite of treatment for months, when fresh ones arise, and troublesome or even painful sensations appear, in which case the urine contains a larger quantity of sugar, that the "surprising discovery" is made. In but a very few cases is the physician led deductively to the probable diagnosis of "diabetes." It is only when careful examination of the urine is made as much a matter of course even in trivial ailments, as feeling the pulse, inspection of the tongue, and palpation of the painful region, or even as frequently as thorough percussion and auscultation, that it will be possible to escape from committing, I might almost say, the "blunder" of not recognising the disease early. It must, however, be admitted that the early phenomena are masked in many respects. Patients complain either of digestive troubles, loss of appetite, heartburn, nausea, vomiting, irregular action of the bowels, colic, &c., or of rheumatism in this or that muscular region, or still more frequently of nerve disturbances—hebetude, headache, indifferent sleep, heat of palms and of soles, depression, no desire for work, &c. When, however, the excretion of sugar is appreciably increased, then all those changes which aroused suspicion of diabetes, acquire greater prominence. They result partly from the nature of the disease itself, *i.e.*, from the incapacity of the body to assimilate the sugar that is taken in the nutriment, partly also from the direct overloading of the blood with sugar, or from its excretion through the urinary system. As the various sources of the symptoms do not permit of easy separation, and there are also "mixed" symptoms, it will be more desirable to discuss them in the order of their frequency and diagnostic value, and then to consider the condition of the various organs. But it must again be emphasised, that there is no fixed rule in this respect, and that exceptions are met with in every case. In fact, with the exception of sugar in the urine, there is scarcely a symptom the presence of which can be reckoned upon with certainty, or which may not be so faintly indicated as to be of doubtful diagnostic value. Again, many a symptom which as a rule is met with at the very outset of diabetes may appear late or not at all. On the other hand, many late symptoms may be observed quite early, which, however, goes to show that we are rarely in a position to determine precisely the commencement of the disease.

1. Polyuria. The patient's attention is generally drawn to this symptom by being awaked through distension of the bladder once or twice during the night, and by the chamber vessel being fuller than usual. The painlessness of micturition and the uninterrupted stream on the one hand, the striking abundance of the voided urine on the other, show that the distension does not depend upon any local cause, such as incontinence or stone. The quantity may be five or six times the normal amount (1500 to 2000 ccm. (50 to 68 oz.) in 24 hours). In diabetes more fluid is got rid of by the urine than is taken into the body in the form of liquid, and is only slightly less than the total amount of water taken, including that contained in the solids. Enuresis nocturna is a frequent observation in children with polyuria, and therefore in such cases the urine should be always examined. Polyuria generally bears a direct relation to the amount of sugar in the urine; exceptions are, however, occasionally met with.

2. Polydipsia and Polyphagia are among the initial symptoms; beginning with dryness of the mouth, excessive thirst is gradually developed. Patients are continually drinking without being able to quench thirst. Appetite increases till it becomes at times bulimia, and especially when meat diet is taken to the exclusion of all starchy foods, many patients cease to know what satiety means. In a minority the opposite condition holds good, viz., complete abeyance of appetite. Even polydipsia alone or together with polyuria may be absent in some cases. Like appetite, the feeling of thirst may be lost (Diabetes decipiens, according to P. Frank).

3. Emaciation. This is not so striking to the eye in many cases of diabetes as in several other chronic affections, *e.g.*, tuberculosis, carcinoma, dyspepsia gravis. Indeed many patients retain their former healthy appearance even at the height of the disease, but more or less decrease in weight is always observable.

Emaciation progresses continually as long as a compensating diet is not followed, or if the disease is not held in check. In my experience, this symptom is one of the earliest and most constant. I well remember a patient, male, ætat. 46, well nourished, whose case I very carefully observed. The only symptom he complained of, was a small but continual decrease in weight during the previous two years. No cause for this loss of flesh could be at all discovered. From time to time traces of sugar were said to have been found in the urine, treatment therefore could only be of an expectant nature. As he was in good circumstances, he retired from business, lived free from anxiety, and was only concerned about attaining his former weight. He consulted several leading physicians in Germany, no diagnosis could be made. Suddenly, after a very severe mental shock, thirst and polyuria appeared, and immediately the very first examination of the urine showed 3·5 per cent. of sugar.

4. Languor. In contrast to healthy persons, who only feel tired after heavy muscular exertion, the diabetic feels weakest and most languid in the morning, even after an undisturbed night's rest. In the course of the day, the languor may disappear, but there is a disinclination for the usual daily occupation, or even for simple outdoor exercise. Slight muscular exertion tires him sooner than formerly. These symptoms are complained of, even at a period when there can be no question of emaciation or muscular atrophy. They are said by certain authors to depend upon an accumulation of the so-called fatigue substances (waste-products: lactic acid, &c.) in the muscles owing to deficient oxidation. However, they may preferably be referred to disturbance of the regions supplied by the nerves of sensation of the muscles similar to that affecting other nerve-territories, which so frequently happens in diabetes.

All the remaining symptoms, of which a short description will be given, belong more or less to the later and last stages of the disease, and many of these may be regarded as sequelæ rather than manifestations of diabetes.

Once more emphasis must be laid upon the fact that, with the exception of sugar in the urine after carbo-hydrates, there is no single symptom which is constantly present.

As regards the symptoms presented by the alimentary tract, those of the buccal cavity are most characteristic. The mucous membrane throughout is generally dry, and the secretion of all the glands is strongly acid (lactic acid?). The tongue is frequently enlarged in breadth as well as in thickness, dry, fissured at the sides, rough at the apex, and bright red. The gums are spongy, discoloured, and tend to bleed; the teeth carious and loosened; and the soft palate presents a white appearance due to slight thrush. Leucoplakia of the tongue and buccal mucous membrane is observed at times, and irregular shrivelling of its papillæ.

Other disturbances of digestion, as loss of appetite, nausea, eructation, vomiting, constipation, or diarrhœa are as frequently present as absent. From personal experience I cannot accept the statement of many observers that digestive troubles are scarcely ever absent in diabetes.

The skin suffers from several affections. As a rule it is cool and dry to the touch, harsh, lax, and branny. In a few cases there is a tendency to frequent and excessive perspiration, either locally or universally. Pruritus (itching) may appear anywhere, but especially in those regions which are liable to come in contact with the sugar-laden urine; thus in the male, the præputium and glans penis (often producing balanitis); in the female, the vulva. Pruritus pudendi is so frequently present in diabetes that it would be a grave error of omission in such cases not to examine the urine.

Furunculosis (frequently recurring boils in various regions, which heal with difficulty) has been observed in diabetes from the very earliest times, and in fact it may precede the disease by a long interval. Carbuncle, however, is a much later affection, and often indeed the immediate cause of death.

The temperature of the body is subnormal in most diabetics; it may sink 2° C. (3·6 F.) below normal, and in coma diabeticorum actually as low as 30° C. (86° F.) in the axilla. Hence patients feel cold even in summer and wrap themselves up in warm clothes, as they learn by experience that their condition becomes worse whenever they get a chill. It is still uncertain what is the cause of the depression of temperature. Some refer it to the non-consumption of sugar as a heat producer, others to the copious cold drinks, to diminished intake of oxygen, or lastly to a disturbance of the thermic centre. At any rate, no constant relation exists between bodily temperature and amount of sugar excreted. The temperature rises only when intercurrent febrile affections attack the patients. It is interesting here to note that many fevers, presumably those that are accompanied by profound tissue changes, during their continuation cause the sugar to disappear from the urine.

The great vulnerability of the skin and other organic tissues is noteworthy. Wounds and ulcers heal exceeding slowly; the greater the amount of sugar, the greater the difficulty in healing. In fact, there is a tendency for injuries to become gangrenous, especially the toes, where a slight wound while paring a corn is sufficient to produce progressive gangrene which cannot always be checked. Moreover, gangrene makes its appearance spontaneously in serious cases, in various regions. Incised wounds rarely heal by first intention. Even scratch marks on the skin, due to pruritus, heal slowly, and readily fester. Hence the urine should be carefully examined every time before resorting to the knife or cautery. Operations which are not very pressing should be postponed until the last traces of sugar have disappeared, and if an operation has been performed, the diet should be most stringently regulated, until the wound has completely healed.

As regards the organs of respiration we have already mentioned that less oxygen is taken up and less carbonic acid and watery vapour given off, than in healthy persons. To what extent this weakened function in diabetes predisposes to lung disease is not yet ascertained. It is remarkable that almost half the number of patients become tubercular and die from phthisis, and that intercurrent croupous pneumonia and gangrene of the lungs are by no means so rare. If acetonæmia is present, as happens most frequently in threatening coma, the breath of the patient becomes tainted with a peculiarly insipid, sour, fruity odour (like must or decaying apples). This is characteristic of diabetes, and is often so powerful as to diffuse itself in the room in a very short time.

As regards the urinary and sexual organs, the nature of the urine is the leading feature; as this is of pathognomonic importance it will be considered later on more fully. Impotence in men is a very important symptom, on account of its frequently being an early one. It varies from defective power of erection, to complete extinction of sexual desire; any change in the testicles or their secretion has only rarely been noted. In females, sterility and abortion frequently occur. Under treatment, sexual power may return. It is but seldom that increase of sexual power with erection and emission, has been observed.

Albuminuria, that at times accompanies diabetes, is of no serious import. It is not connected with any textural change in the kidneys, for pus, blood, and casts are absent from the urine, nor is it constant, often disappearing for some time. Finally, it is of no importance as regards the loss of nitrogen the body suffers from, as the percentage never exceeds $\frac{1}{10}$ per cent., and this waste of albumen is amply compensated for by the increased meat diet.

Some regard albuminuria as a consequence of the exalted function of the kidneys, which are generally found enlarged post mortem, others as the result of swelling and fatty degeneration of the renal epithelium. Naturally, albuminuria is important in those exceptional cases of diabetes which are complicated by granular contracted kidneys (Bright's disease).

Changes in the organs of sense. Of these, the eye is most frequently involved. Either visual power suffers (amblyopia), or accommodation becomes weakened at an earlier period than usual. Many patients even are compelled to resort to correction lenses when they are between 30 and 40 years of age. Palsy of the sixth nerve (abducens, external rectus) occurs very seldom, and still seldomer of the other ocular muscles. Cataract is of most frequent occurrence, and one eye usually loses its sight long before the other. From statistics of a large number of cases compiled by various authors, the average percentage of cataracts due to diabetes varies from 6 to 7 per cent. The cataract which begins at the periphery of the lens often remains stationary for a long period. With improvement in the disease, *i.e.*, disappearance of sugar, complete involution of the cataract may actually take place and cloudy areæ clear up. Amblyopia and paresis of accommodation may likewise improve.

Retinitis diabetica is not so frequent, but all the more characteristic when present; ophthalmoscopically it very much resembles Retinitis albuminurica. It oftens happens that the ophthalmic surgeon is the very first to have the urine tested for sugar, his suspicions being aroused by the results of his examination.

Besides the eye, the gustatory nerve is liable to be affected. A mawkish and sweet taste is constantly present, so that patients either do not taste their food at all, or everything seems sweetened. To many this even amounts to loathing, which is all the stronger the longer they have been deprived of sugar. It is remarkable that many diabetics without any gustatory affection, who have discarded the use of sugar for some time, are not able to enjoy anything sweet, and least of all saccharin offered as a substitute. Griesinger reports some cases of dulness of hearing in diabetes. Hitherto I have not observed a single case, although I have noted here and there tinnitus aurium in the absence of other signs of disease of the middle or internal ear.

Condition of the nervous system. On account of the almost positive ætiological relationship between diabetes and disease of the central nervous system, several forms of nerve disturbance may be expected *a priori*. In fact there is probably no single case in which one nervous symptom or another is not prominent. Owing to their somewhat frequent occurrence, some of these have already been described at length, *e.g.*, impotence, amblyopia, languor, &c. Next in importance is agrypnia, which may exist to a very marked degree. I remember some cases where, according to the statements of the patients and their friends, for several years 2 hours sleep out of 24 was quite sufficient for their requirements. Insomnia is very difficult to surmount, even when every trace of sugar has disappeared from the urine and the general condition improved.

Disturbances of common sensation are not infrequent. Paræsthesiæ, pins and needles, formication, sensation of oppression at the joints, of heat, and of cold, in various regions. Hyperæsthesiæ, or even severe neuralgia generally in the course of the great sciatic nerve, in the occiput, or under the well-known form of hemicrania, besides in various joints as well as in internal organs, *e.g.*, stomach, uterus, ovaries, kidneys, &c. Their spontaneous and bilateral appearance, the severity and long duration of the paroxysms, accompanied by the rapid development of vaso-motor disturbances in the affected regions, are characteristic of diabetic neuralgias.

Motor disturbances, in the form of Pseudo-tabes, slight ataxia, and diminished patellar reflexes, are rarely seen, paralysis practically never, while cramp and clonic muscular twitching are met with occasionally. (Coma diabeticorum must be regarded as a nerve symptom. This, which usually forms the tragic end of diabetes, will be depicted separately in dealing with the course of the disease.) Changes in metabolic activity, emaciation, diminished consumption of oxygen, and depression of temperature, &c., have already been referred to. Other symptoms, of which mention is made in the literature of the subject, may be dismissed on account of their rarity and transient character.

DIAGNOSIS—EXAMINATION OF URINE.

The diagnosis of Diabetes mellitus can only be thoroughly and satisfactorily established by demonstrating the presence of a considerable physiological excess of grape sugar in the urine. Without this proof, even in the presence of other symptoms of diabetes, there is at most only room for suspicion. For there are several conditions of ill-health accompanied by a temporary excretion of sugar which must be distinguished pathologically, prognostically, and therapeutically from true diabetes, and which we designate Glycosuria. Hence the differential diagnosis must be sharply defined and the latter positively excluded; of course this cannot always be determined after one or even several examinations. In fact it may require weeks of careful observation before the physician can certify that his patient is suffering from diabetes; a hasty opinion has often caused a good deal of distress. The consciousness of suffering from an incurable disease produces a severe shock at all times which must not be overlooked, and it must also be borne in mind that long persistent mental depression may actually induce diabetes from glycosuria. (The essential difference between the two has already been sufficiently set forth, *v. supra.*)

Again, diabetes should not be excluded because a single examination of the urine reveals a negative result, for by far the great majority of cases (the slight form of diabetes) excrete no sugar in the absence of carbo-hydrates and when the muscular system is active. If we examine the urine after an interval of some ten to twelve hours without food—for instance, that passed on rising in the morning—only slight traces of sugar, or none at all, may be discovered; but an hour after breakfast (generally white bread and sweetened coffee) it may disclose 4 to 5 per cent. of sugar.

Therefore each examination should be made some two or three hours after a full meal, which for purposes of greater certainty should consist of well-sweetened and farinaceous food. It should not be made after a long fatiguing journey or after severe mental strain, for both these factors may temporarily cause a marked increase in the amount of sugar, and thus lead to an error in diagnosis. It is particularly difficult to decide between accidental glycosuria and diabetes, when only a small quantity of sugar is present (from ·5 to 1·5 per cent.), contrariwise, it is quite easy when the amount exceeds 2 per cent. Urine which contains more than 2 per cent. of grape sugar can only be that of a diabetic patient. All the forms of glycosuria—artificial, symptomatic, toxic, and traumatic—show at most only slight traces of sugar. The single exception is the glycosuria produced by phloridzin, when an enormous quantity of sugar (from 10 to 19 per cent.) may be excreted.

The question arises, whether those cases where only a very small quantity (·1 to ·2 per cent.), or even a distinct though inappreciable trace of sugar is found are to be regarded as diabetic? Many authors are decidedly of the opinion that such traces should not be viewed as diabetes, but as symptomatic glycosuria, accompanying some latent or as yet unrecognised disease. I cannot subscribe to this view. Several cases are known to me—among others the one mentioned above—where quite insignificant traces of sugar were accompanied by serious symptoms peculiar to diabetes (emaciation, languor, sleeplessness, &c.), and where these troubles only yielded, or at any rate improved, from the moment the patient was placed on strict anti-diabetic diet. Every physician who has had opportunities of observing a large number of cases of diabetes, will probably have come across some in which long persistent traces of sugar left the diagnosis doubtful, but where a casual shock to the nervous system has suddenly caused a considerable increase. In my opinion even the slightest trace of sugar that can be distinctly recognised should not be lightly considered, but rather the case should be attentively watched for some time, and the urine passed at different times during the day examined at least twice a week. Although exact proof of grape sugar in the urine can only be determined by chemical examination, yet its physical characters afford several grounds for inferring its presence. Chief among these is its high specific gravity, for whereas normal urine has a sp. gr. of 1015 to 1020, which when concentrated from diminished imbibition of fluids may rise from 1024 to 1026, diabetic urine may show a sp. gr. of 1045 and upwards. In many pathological conditions, such as high fever, lead colic, acute Bright's disease, &c., the urine is laden with uric acid, but the specific gravity is never as high as that of diabetic urine. Where the urinometer, which is usually first employed, shows a very high specific gravity, strong suspicion of the presence of sugar is aroused. This speedy and easy method of examination is not only of relatively great value as a qualitative test, but, as we shall see later on, may be used to estimate the quantity of sugar. The colour often offers another mode of recognition, this is, from the presence of polyuria, pale yellow with a greenish tinge, and sometimes as clear as water. When such pale urine has also a high specific gravity, there is no doubt about the presence of sugar, for with the exception of uric acid there is no other substance in urine able to raise it so much, and dilute urine contains only little uric acid. As a rule it is clear; after long standing acid fermentation readily takes place, and it becomes cloudy owing to fermentation products. The reaction of diabetic urine is almost without exception acid, and this persists for a very long time in spite of the large amount of ammonia present, and the constant use of alkalies. As is well known, normal urine becomes alkaline very soon after the administration of alkaline waters. The odour is peculiarly aromatic, smelling of hay, and when fermentation begins, of sour wine. The taste is distinctly sweet when a fair amount of sugar is present. White spots (deposit of sugar, on the evaporation of urine) are not unfrequently seen, when it is abundant, in the immediate neighbourhood of the urethra, on the linen, and even inside the chamber vessel.

The sugar excreted in diabetes is termed grape sugar, starch sugar, glucose, or dextrose; it is characterised by its solubility in water and alcohol, by its property of undergoing fermentation, and of turning the plane of polarised light to the right, and by its power of reducing the salts of copper in alkaline solutions. Other forms of sugar produced from glycogen by the action of animal and so-called diastatic ferments, capable of isolation (saliva, pancreatic juice), possess greater rotatory, but much feebler reducing powers. Besides sugar the amount of urinary solids is increased above the normal; this is easily explained by the increased proteid waste, as well as by the increased amount of nitrogenous food generally consumed, even the excess of water drunk is sufficient to effect a greater elimination of urinary solids. Uric acid is constantly present, although apparently in smaller quantity than normal. The important *rôle* the increase of ammonia plays, as regards coma diabeticorum, will be more fully explained in connection with the latter.

The knowledge of the relation of other urinary constituents (sulphuric and phosphoric acids, chlorine, and the alkaline earths, &c.) in diabetes has more scientific than practical value. Of abnormal elements calcium oxalate is fairly frequent, and in such abundance that the microscopic field always shows a few crystals easily recognised by the envelope pattern. Oxaluria is therefore important, and its significance is heightened, as it not infrequently precedes diabetes for some time, and may even alternate with the excretion of sugar.

Acetone and diacetic acid may be met with in the slighter as well as in the graver forms of the disease, naturally more often in the latter; they are, however, frequently absent in both. Albumen has already been mentioned; it is important to test for this before commencing to examine for sugar, and if the former be present it must be got rid of, so as not to interfere with the sugar tests.

Fungi and bacteria grow very soon in diabetic urine, especially if kept standing in a warm place. For the sake of completeness, allusion must be made to a recent communication of Professor Müller's, of Bonn, concerning an exceedingly rare case of pneumaturia. Here acid fermentation had already commenced in the bladder, and the evolved gases—carbonic acid and hydrogen—were voided with the urine, making a loud report. It sometimes happens that if fermenting urine be allowed to stand in a warm place no sugar can be detected after a time, owing to complete fermentation.

CHEMICAL EXAMINATION OF URINE.

Examination must be preceded by removal of any albumen that may be present. This is best effected by boiling. Normally acid urine is heated in a test-tube up to boiling point; if it be neutral or alkaline a few drops of dilute acetic acid must first be added. The coagulated albumen is removed by filtering, and the filtrate is then ready for carrying out the following qualitative tests.

1. Heller's—also called Moore's—test. From 5 to 10 ccm. (♏ 81 to ♏ 162) of urine are poured into a test-tube and one-third its volume of concentrated solution of caustic potash (liq. potassæ B.P.) is added. The two are well shaken together, and half is poured into another test-tube and then boiled. If sugar is present it becomes distinctly darker than the unboiled half. This change is the result of the action of caustic potash on sugar during boiling; the depth of colour varies as the amount of sugar present, and when it is abundant, the fluid has the colour of Jamaica rum. However, as almost every specimen of urine after addition of caustic potash and subjected to heat becomes brown, this should only be used as a preliminary or control test.

2. Trommer's test. 5 to 10 ccm. of urine are placed in a test-tube along with one-third its volume of caustic potash or soda; after thorough agitation a few drops of a solution of cupric sulphate (cupric sulphate 1 part, distilled water 10 parts) are added. The pale blue flocculent precipitate of hydrated oxide of copper dissolves on shaking if sugar be present in any quantity. The copper sulphate solution is added drop by drop, the mixture shaken, until a trace of cloudiness persists in spite of repeated agitation. Heat is now applied to the upper layer until boiling is nearly reached, when a yellow or red precipitate of hydrated suboxide of copper appears, formed by the reducing action of the sugar upon the cupric oxide in an alkaline solution.

3. Fehling's solution test. This rests upon the same principle as the preceding test, but the necessary reagents (an alkaline solution of sal seignette [sodium potassio-tartrate] and a dilute solution of cupric sulphate) are freshly mixed every time. The resulting fluid—the so-called Fehling's solution—has a beautiful azure blue colour, in which precipitation of the suboxide of copper is prevented by the presence of tartaric acid. In order

to ensure success of the test the following conditions must be observed.

(1) The solution must be well diluted, though of course it must retain its alkaline reaction.

(2) The dilute solution must be heated before the addition of urine, in order to be quite certain that the fluid itself has not become capable of reducing the copper owing to decomposition of the tartaric acid.

If to the heated solution a few drops of urine are added, a precipitate similar to that in Trommer's test appears if sugar is present.

The two last-mentioned tests are the most frequently used as comparatively convenient and trustworthy when there is a fair amount of sugar. The following are severer tests to determine traces of sugar.

4. Böttger's test. From 5 to 10 ccm. of urine are placed in a test-tube together with a quarter its volume of concentrated caustic potash. A small piece, about the size of two pins' heads, of magisterium bismuthi (basic nitrate of bismuth) is dropped into the test-tube and the whole heated for some minutes up to 100° C. In the presence of a large quantity of sugar, metallic bismuth is thrown down, recognised by the sudden turbidity of the fluid and the collection of a black precipitate at the bottom of the test-tube; if there is only a small quantity of sugar present, the precipitate is of a grey colour (suboxide of bismuth). In the presence of albumen this otherwise reliable test may undergo serious modifications, and on this account is seldom used in practice.

5. But for demonstrating traces of sugar, Seegen's test is to be preferred. The urine is passed through a covered filter made of thoroughly purified blood charcoal. The filtrate contains a small portion of the sugar and other constituents of the urine; all the colouring matter and the bulk of the sugar are retained in the charcoal. This is well washed with water, which dissolves out the sugar; the first washing consists almost of a pure solution of sugar, which, even when the quantity is quite small, gives indubitable results with Trommer's or Fehling's test. The second and third washings often yield distinct reactions; hence Seegen's blood-charcoal test is specially suited to the detection of mere traces of sugar, and its use should not

be omitted when the results of the previous mentioned ones are at all doubtful.

6. Fisher-Jaksch's test. 50 ccm. of urine are decomposed by 2 grams (about 30 grs.) of phenylhydrazin hydrochlorate and 3 grams (about 45 grs.) of sodium acetate and heated for some thirty minutes in a water bath. On cooling, which may be accelerated by immersion in cold water, a yellow precipitate appears easily recognisable when there is a large quantity of sugar present. Microscopically, it consists of yellow needles and spheroids, and from its combination with the sugar is termed by E. Fisher Phenylglycosazine. The applicability of this very favourite test has lately been questioned, owing to the discovery made in Plosz's laboratory, that besides sugar, another constituent of normal urine—probably a compound of glycuronic acid—also has the property of forming with phenylhydrazin, a yellow substance consisting of acicular crystals.

For the purposes of exact diagnosis a quantitative determination of the sugar must be based upon all the urine passed in 24 hours, as it is not so much a question of the percentage of sugar in any given specimen, as of the quantity excreted with the urine during the whole period. For instance, should the urine show 4 per cent. of sugar, and the amount passed in 24 hours be 5 litres (about 169¼ fl. oz.), then $4 \times 50 = 200$ grms. (about 3,000 grs.) of sugar are excreted; again, if the amount of sugar be 7 per cent. and the urine passed 2½ litres (about 84½ fl. oz.), then $70 \times 2\frac{1}{2} = 175$ grms. (about 2,630 grs.) are excreted daily.

The following are the methods of estimating the sugar in the urine quantitatively:—

1. By employment of Fehling's solution.—The principle is the same as that of Trommer's test, namely, the reduction of the oxide of copper to the suboxide by grape sugar in an alkaline medium. As five parts by weight of grape sugar free from water reduce 34·639 parts by weight of pure copper sulphate, the two solutions are made in the following proportions:—

I. 34·639 grms. of pure copper sulphate are dissolved in water by heat, and then diluted to form 500 ccm.

II. 173 grms. of sal seignette (sodium potassio-tartrate) are dissolved in 350 grms. of pure caustic soda (sp. gr. 1·14) and diluted with water to form 500 ccm.

Both solutions must be kept in well-stoppered bottles. Before each examination, equal portions are mixed together (forming Fehling's solution) and heated; no suboxide of copper should be thrown down.

Five ccm. of each solution are taken, diluted fourfold with water, and placed in a porcelain evaporating dish. Then a portion of the whole urine passed in 24 hours is diluted ten times with water (1 urine to 9 water) and poured into a burette. The contents of the evaporating dish are brought to the boiling point, the dilute urine in the burette is added, drop by drop, and the gradual decoloration of the blue liquid by the suboxide of copper watched for. Causse proposes by adding 4 ccm. of a 5 per cent. solution of ferro-cyanide, diluted with 10 ccm. of water to the 10 ccm. of Fehling's solution, in order to render the suboxide of copper colourless, so that the disappearance of the blue colour may be all the more striking. The moment the solution is completely decolorised (ascertained by tilting the evaporating dish) reduction is complete, and the amount of diluted urine used is read off from the burette.

Calculation.—Since 10 ccm. of Fehling's solution contains ·34639 grms. of copper sulphate, ·05 grms. of grape sugar are required for its complete reduction. For instance, if 12 ccm. of dilute urine have been used, then this amount represents ·05 grms. of grape sugar, and as the urine was tenfold diluted, 1·2 ccm. of urine contain ·05 grm. of grape sugar. By proportion, $1{\cdot}2 : {\cdot}05 :: 100 : x$, $x = 4{\cdot}16$ grms. in 100 ccm. of urine. If 3·5 litres of urine are passed in 24 hours, the total amount of sugar excreted per diem would be $4{\cdot}16 \times 35 = 145{\cdot}6$ grms. (about 2,185 grs.). Errors of this method: the presence of other substances capable of reducing the copper (uric acid, creatinin, glycuronic acid).

2. The amount determined by fermentation.—This depends upon the fact that sugar is split up into alcohol and carbonic acid by yeast fermentation. An apparatus consisting of two small bulbs connected by a glass tube is used. From 10 to 20 ccm. of urine is placed in one bulb, together with yeast and a little tartaric acid, the other is half filled with concentrated sulphuric acid. The whole is then weighed and set aside for some days in a temperature of 20° to 25° C. When the evolution of carbonic acid is complete, which is recognised by the clearing up of the cloudy fluid, the bulb may be gently heated in

order to get rid of any remaining carbonic acid; any water of evaporation is retained by the sulphuric acid. The apparatus is then weighed, and the loss of weight corresponds to the amount of carbonic acid evolved—48·89 parts by weight of carbonic acid being equivalent to 100 parts by weight of grape sugar.

Errors of this method: formation of a small amount of glycerine and succinic acid from the sugar, and possible evolution of carbonic acid from the yeast.

Both these methods, which occupy a considerable amount of time and require great precaution so as to yield satisfactory results, are only suited for scientific research. In general practice, the polarisation method meets all the requirements of easy and rapid execution and sufficient exactness.

3. Determination by the polariscope.—This method depends upon the property of grape sugar deflecting the plane of polarised light to the right. The production of polarised light by means of a Nicol's prism, is common to every apparatus. A second one is so placed that every possible rotation is compensated and the so-called normal state is created. Any changes from the normal state caused by a saccharine solution of a certain thickness (usually one or two dcm.) are counterbalanced by a corresponding rotation of the second prism. When the apparatus is set, the index points to 0 or the scale, and when rotated, the index moves (up to 50 or over).

The usual instruments are:—

1. Mitcherlich's older apparatus.—Normal state: field of vision, in homogeneous light, dark, the ray, in daylight purple-violet. Change: field of vision, at first bright, then coloured. Calculation, $p = \frac{a \times l}{a \times 100}$, where p = percentage, a = the indicated rotation, a = specific rotatory power of grape sugar, l = length of tube.

2. Soleil-Ventzke's saccharimeter.—Normal state: field of vision, both halves coloured the same. Change: dissimilar colouration. Calculation: each division of the scale indicated 1 per cent., *i.e.*, 1 gram of sugar in 100 ccm. of fluid.

3. Laurent's half-shadow apparatus.—Normal state: field of vision, both halves equally bright. Change: unequally bright. Calculation: each degree = 1 per cent. of sugar, if $l = 1$ dcm.

4. Wild-Savart's Polaristrobometer.—Normal state:

field of vision, uniformly bright. Change: appearance of parallel black streaks. Each division = ·2 per cent. of sugar.

Errors of the polarisation method: presence of other substances, dextro- or lævo-rotatory, difficulty of fixation of the instrument with dark-coloured urine (if this is decolourised by acetate of lead, as is usually the case, a considerable quantity of sugar is lost in the process).

In the absence of other means, the urinometer may be used as an indicator, where the quantity of sugar excreted is considerable. For, with a large amount of sugar in greatly diluted urine, the change in the specific gravity, which varies tolerably regularly with the quantity of sugar, and by means of Häser's coefficient 2·33, an approximately serviceable conclusion may be arrived at. Thus if urine after considerable dilution show a sp. gr. of 1030, then 30 × 2·33 = 69·9 grms. in a litre, or 6·99 per cent. of sugar will not be far from correct.

The perchloride of iron reaction serves to demonstrate the presence of diacetic acid (acetic vinegar, according to Gerhardt, aethyl-diacetic acid). On the addition of this reagent the urine assumes a red-brown colour, which disappears on adding hydrochloric acid. If the urine be previously boiled for half-an-hour, no reaction with the perchloride of iron takes place, but an odour of acetone is frequently given off.

For the demonstration of acetone in the urine:—

I. The so-called Iodoform reaction may be employed. A small quantity of urine is decomposed by caustic potash and by excess of a solution of potassium iodide containing iodine. After standing for a short time, six-sided crystals of iodoform separate out, and its characteristic odour is perceptible.

II. The nitro-prussiate of Sodium reaction. A beautiful red cloud is obtained on adding to the urine caustic potash and a solution of nitro-prussiate of sodium.

Schlössing-Neubauer's method may be used for determining the presence of ammonia in the urine. This depends upon the ammonia, which exists free in a watery fluid, evaporating and subsequently undergoing absorption by dilute sulphuric acid in a confined space. For the execution of this test, the following reagents are necessary: 1. Normal sulphuric acid (1 ccm. of the acid containing ·04 grm. of SO_3); 2. Freshly prepared lime water; 3. Normal caustic soda solution (1 ccm. neutralising

1 ccm. of oxalic acid solution containing ·063 grm. of oxalic acid), of which 1 ccm. neutralises 1 ccm. of sulphuric acid.

From 10 to 20 ccm. of urine are poured into a small evaporating dish, together with an equal quantity of lime water. On this a glass triangle is placed, supporting a shallow dish containing 10 ccm. of normal sulphuric acid. The whole is set under an air-tight bell-jar. After 48 hours, the sulphuric acid will have absorbed all the ammonia. The amount of sulphuric acid that remains free is then ascertained by neutralising with normal caustic soda solution. For instance, if 9·5 ccm. of soda solution are required to neutralise the sulphuric acid, then 9·5 ccm. of the latter were present, and consequently ·5 ccm. were used to neutralise the ammonia in the urine. Since 1 ccm. of normal sulphuric acid solution neutralises ·017 grm. of ammonia, then the 10 ccm. of the mixed urine contain ·017 × ·5 = ·0085, and a litre therefore ·85 grm. of ammonia. Patients who pass from 3 to 4 litres (100 fl. oz. to 133 fl. oz.) of urine daily would therefore excrete from 2·45 to 3·40 grms. (36¾ gr. to 60 gr.) during that time.

PROGNOSIS AND COURSE.

Prognosis manifestly depends on the answer to the question whether Diabetes mellitus is a curable disease or not. The word "cure" scientifically means "restitutio ad integrum," that is to say, the materies morbi, whether organic or not, is removed from the body, or destroyed and rendered innocuous, and the various tissues healed so as to allow the exercise of their functions, even if with diminished vigour. For the idea of "cure" no more excludes recurrence or diminished resistance to other diseases (in an organ previously attacked) than it does the destructive sequelæ in the organ primarily affected or in others. Such sequelæ often represent a new disease. For example, a patient, after having passed through an attack of pneumonia or typhoid fever may possibly feel the consequences of these diseases for some time to come. The lungs may be impaired, as is shown by a tendency to bronchial catarrh, or the bowels may be affected with enteric catarrh. Still he is regarded as having recovered from pneumonia or from typhoid fever. With diabetes it is otherwise. Even if, after suitable treatment and regulated diet, a patient is able to assimilate a fair amount of carbo-hydrates and feels well enough to resume his occupation, the disease is only at a standstill or latent, and certainly cannot be said to have ceased. For the moment he exceeds, by ever so little, the small amount of carbo-hydrates he can safely digest, or is attacked by any fresh predisposing cause, diabetes ever and anon occurs in spite of quiescence of many months' or even years' duration. Senator compares diabetics to bleeders, who remain free from danger as long as they avoid injury—apparently healthy, they still suffer from hæmophilia. As little as the latter are able to protect themselves for their whole life against accidental injury, just as little, or even less so, are diabetics from dangers which constantly lurk under the ordinary conditions of life. In this sense, therefore, diabetes must be regarded as incurable; all diabetics, if not carried off by some intercurrent affection or by a violent death, succumb sooner or later to the usual termination of the disease. Those occasional cases of complete cure reported of late must be consequently regarded with a certain amount of suspicion. Every experienced physician in Carlsbad must know how many of the so-called cured patients return thither after a few years as genuine diabetics. And Seegen, among 800 carefully observed cases, has not seen a single one cured. This may be taken as deciding the question. Hence the prognosis in Diabetes mellitus must be considered throughout as unfavourable. The mean duration of the disease could only approximately be determined, were it possible to place all the observed cases under similar conditions of life. The poorer classes, who are not in a position to avoid danger by adhering to a preponderating meat diet, succumb sooner to the disease than the well-to-do, who are able to regulate their lives accordingly and thus take care of themselves. While for the former, life may average a duration of three years, for the latter, it may last twice as long. Cases are exceedingly rare where death takes place within a few months or even weeks. Age has a great influence over the duration of diabetes. In young persons (from 20 to 35 years) the prognosis is decidedly more unfavourable than in older. Symptoms are not only severer and more numerous, but the danger of early and speedy death is greater. In children (under 12) it is still a somewhat rare disease; out of 117 cases collected by C. Stern from the literature on the subject, prognosis is far away most unfavourable in childhood. Positively remarkable and inexplicable is the great tolerance of old age (about 70). It is not rare to find among the last cases, in the presence of very considerable quantity of sugar (300 grms. [4,500 grs.] and more per diem), quite insignificant symptoms—somewhat disturbed sleep, slight languor, slight increase of thirst and of appetite, &c.

I know an old lady who has been diabetic for 10 years, where the urine shows an amount of sugar from 4 to 7 per cent., and in addition contains albumen, who will not submit to anti-diabetic regimen, and whose general condition is so good, in spite of slight œdema of the ankles, that she is able to go about enjoying without hindrance all the pleasures of society, and will have nothing to do with any medical treatment.

As regards prognosis and duration, it is of great importance to determine whether diabetes at the outset is of the grave form, *i.e.*, whether from the very beginning sugar is excreted, in spite of exclusive meat diet. Such cases are the saddest of all. Even in the slight form of the disease, the prognosis must be guarded; for, in the first place, the patient may unexpectedly succumb quickly to one or other of the terminations of diabetes; and secondly, because the grave form may suddenly appear from some severe injury, or even without any manifest cause. Conversely, I have also noticed some cases which passed into the grave form after a severe nervous shock, and continuing so for some weeks, returned to the slight form with subsidence of the nervous disturbance. Last summer, in Carlsbad, I observed a very striking case of this kind. A lady, whose statements may be thoroughly relied upon, had been suffering for three years from a very slight form of the disease, inasmuch as every trace of sugar disappeared as soon as she was placed on anti-diabetic diet. At the beginning of the Carlsbad treatment in the previous year she was much distressed at the sudden death of a member of her family, and passed several sleepless nights. Thereupon, sugar reappeared in the urine (3 to 4 per cent.), and the excretion persisted for 14 days, in spite of rigid observance of Cantani's diet. No one could doubt that the grave form arose out of the slight; 14 days after, however, the sugar gradually decreased, and at the end of the third week the slight form returned, and during the last days of treatment the patient was even able to enjoy a moderate amount of carbo-hydrates without excreting a trace of sugar. It is difficult, in the light of such experience, to accept the division by Seegen of diabetes into two sharply defined forms; it is much better to regard them as differing in degree only. The percentage of sugar taken in connection with the amount excreted per diem is often of little value as regards prognosis. Not every diabetic with 6 to 7 per cent. of sugar is threatened with imminent danger; on the other side, patients with 1 to 2 per cent. may be attacked by serious symptoms. In the majority of cases, however, the percentage of sugar is a fairly reliable guide in judging of the gravity of a case. Of the symptoms of diabetes, rapid emaciation and the presence of nerve disturbances, *e.g.*, persistent sleeplessness, neuralgia, &c., are of the gravest significance. The diseases to which diabetics usually succumb may be regarded as the direct consequences and results of diabetes; they are the immediate cause of death.

1. Pulmonary Phthisis (almost half of the autopsies). The well-known picture of consumption is gradually developed, even in those where there is no family history of tubercle—apical catarrh, hæmoptysis, night-sweats, &c. Tubercle bacilli are very rarely absent.

2. Croupous Pneumonia and gangrene of the lungs. In the latter the characteristic odour of the expectoration is almost masked by the presence of acetone in the expiratory air.

3. Early Marasmus—extreme exhaustion, sloughing of the skin, and necrosis of bone.

4. Formation of Carbuncles.

5. Albuminuria. Even without serious renal lesion, large quantities of albumen may be excreted quite sufficient to bring about death. Senator holds that the albuminuria may possibly depend on irritation of the floor of the fourth ventricle, which has spread forward from the diabetic centre to that spot where, by means of experiment, albuminuria is produced.

6. Fatty degeneration and malignant disease of the pancreas accompanied by occlusion of the bile-duct and well-marked icterus. Griesinger's statement that Diabetes mellitus confers a kind of immunity from heart disease, rheumatism, and cancer, appears to be erroneous, at least as regards the last-named.

7. Transition of Diabetes mellitus into Diabetes insipidus. An exceedingly interesting but extremely rare result of diabetes. Frerichs has observed a few cases, which he has described in his book on the subject. This gain is not of much value, as Diabetes insipidus is likewise incurable.

8. Coma diabeticorum. Next to pulmonary phthisis this is the most frequent termination of the disease. Coma sometimes overwhelms the patient suddenly in the midst of his usual activity, or whilst quite cheerful and free from mental or bodily worry. Often, however, excess of various kinds, hard work, fatigue from travelling, over-indulgence of the sexual passion, &c., precede coma, which is sometimes ushered in by brief prodromata (malaise, anxiousness, stomach-ache). The patient passes into sleep which, at first interrupted by grave excitement, soon assumes a comatose character. The pulse becomes small and rapid, respiration is very deep, at times normal in rate, at times very hurried. The bodily temperature gradually sinks as low as 30° C. (86° F.), and the extremities are quite cold to the touch. The urine, which dribbles away involuntarily or is drawn off by the catheter, gives almost always the reaction of diacetic acid on addition of perchloride of iron. This condition may last from one to three days without any return to consciousness, but generally terminates much more speedily in death.

The cause of coma diabeticorum is not yet fully explained. The former view that it is caused by the poisoning of the blood with acetone or diacetic acid has been discarded, as the injection of these substances into the circulation of lower animals failed to produce similar phenomena. Abeles found in some cases of coma diabeticorum considerable quantities of glycogen in the brain, which normally contains none. But he does not ascribe to its presence any influence in the production of this state; rather he believes that in every grave form of diabetes, glycogen exists in the brain, and its demonstration is rendered possible only by rapid death due to coma. It is well known that usually even the sugar disappears a few days before death.

Stadelmann, of Dorpat, has lately noted the presence of an acid in diabetic urine which he at first regarded as crotonic acid, afterwards as oxy-butyric acid, previously found by Külz and

Minkowski. He refers the origin of coma to this acid; he found whenever the urine contains diacetic acid, oxy-butyric acid is also always present, even if the former be absent. In his opinion the perchloride of iron reaction has a very important signification, as it betrays the presence at the same time of oxy-butyric acid. *Pari passu* there is an increased excretion of ammonia (3 to 4 grms [about 46 to 62 grs.] of ammonia to 30 grms [about 450 grs.] of oxy-butyric acid). Stadelmann considers the increase of ammonia in the urine as one of the most important prognostic signs. If more than 1·10 grms (16½ grs.) are excreted daily, the danger threatens that diabetes will pass into the grave form. Should it amount to 2—4—6 grms. (about 31—62—93 grs.) daily, the sudden appearance of coma may be constantly expected, and the friends of the patient should be warned.

Treatment of coma diabeticorum. If the ammonia is on the increase the meat diet must be diminished forthwith, bread, vegetables, and fruit substituted in moderation, and the following draught ordered:—

			About.
℞	Acidi citrici	grm viij.	(123 grs.).
	Sodii carbonatis	grm xviij.	(278 grs.).
	Saccharini	grm ·1	(1½ grs.).
	Aquæ destillatæ	grm CL	(5 oz.).
	Spiritus menthæ Piperitæ gtt iij.		
	S. To be taken two or three times in 24 hours.		

If coma is already present, Stadelmann recommends without delay intravenous injection of a solution of carbonate and chloride of sodium (7 to 10 grms. [about 108 to 150 grs.] of sodium carbonate to every 100 grms. [about 1,500 grs.] of normal sodium chloride solution) varying from 1 to 1½ litres [about 33¾ fl. oz. to 50¾ oz.] which should be discontinued the moment threatening symptoms manifest themselves—stopping of the pulse or of the respiration, or presence of convulsions—to be renewed after an interval or so. Formerly subcutaneous injections of camphor, ether, cold affusion, and other excitants were employed, unfortunately without success. It remains to be seen whether the intravenous injection of alkalis is followed by better results.

TREATMENT.

Since John Rollo made the important discovery at the close of the 18th century that in every case of diabetes the consumption of sweet and starchy foods greatly increased the quantity of sugar excreted, it was thought that by simply withdrawing these articles of diet the disease could be cured. The object of the physician was to hit the right choice of food and of beverage, so as to prevent the entrance of as little carbo-hydrate material as possible. The conviction was soon reached that although the patient's condition could be much ameliorated, still complete cure could not be attained. Now, alas, we must confess with regret that even after the lapse of a century we are still very far from the desired goal, and at present have no well founded hope of ever reaching it. Modern treatment, however, has certainly been able materially to alleviate the condition of the patient as well as to considerably prolong his life.

The following fundamental principle of universal value to medical men has been the greatest acquisition in later years: no routine treatment, but each case to be treated in strict accordance with the form of diabetes it presents. Of the numerous ones that have been constructed analytically and synthetically none has hitherto proved to be universally applicable; for what may be useful in one case, may be harmful in another. This holds good, not only in medicinal, but also in hygienic and dietetic treatment. For even though it be beyond dispute that anti-diabetic diet, consisting of vegetable and animal products which contain the least possible amount of sugar and of sugar-forming substances, plays the most important part of all in the treatment of the disease—which moreover in the great majority of cases is of distinct benefit—still cases are met with in practice in which a rigid diet is not only of no use, but is absolutely harmful, does not relieve symptoms, but actually aggravates them. This is chiefly true of the graver form of the disease, but especially so when prodromata of coma are present (*v. supra*). If a less rigid diet be allowed, *e.g.*, bread, vegetables, fruit, although the amount of sugar may be increased the patient will feel considerably better, and may recover to a certain extent. In any case, the improvement of the general health and nutrition of the patient is of the first importance rather than the diminution of sugar. On the above principle every method of treatment of diabetes has therefore only a limited value.

Priorry's proposal to replace the loss of sugar by increasing the amount taken as food, like the attempt to replace the loss of proteid material in albuminuria by increasing the amount of meat, may be dismissed "a limine," for could the loss of sugar be compensated, none would be excreted. The same holds good with glycerine, which Schutzen recommended on erroneous theoretical premisses as a substitute. Even Donkin has but few followers of his treatment, consisting exclusively of skimmed milk; it can scarcely be imagined that nutrition would not suffer severely in a very short time. The injuriousness of this method has already been demonstrated by several writers.

The hygienic-dietetic natural method of treatment of A. v. Dühring is simply paradoxical. He allows his patients rather large quantities of carbo-hydrates in the shape of stale white bread, rice, peas, haricot-beans, and dried fruits, and only excludes sugar. He maintains that these vegetables, dried apples, plums, and cherries, when soaked in cold water for a day and then well cooked over a slow fire for several hours, in spite of the large amount of carbo-hydrates, form no derivatives of sugar, but are digested and assimilated (?). Several control experiments discountenanced this supposition. On the other hand v. Dühring's hygienic treatment—the use of cold water in the form of wet pack and cold friction, plenty of muscular exercise in the open air, home gymnastics, and respiratory exercises—is quite rational in suitable cases, and its efficacy cannot be gainsaid. It remains uncertain whether the successful results, even in the grave forms that v. Dühring's method boasts, are true recoveries or only temporary ameliorations.

Similar routine methods of treatment, wrongly termed systematic, should have no place in diabetes—a disease, as ætiology tells us, which appears at one time to develop from nervous causes (psychoses), at another from constitutional (obesity, gout), and again from organic disease (pancreas and liver). Moreover, when we take into consideration how different the nature of every individual and the predisposing causes (diminished power of resistance, inherited disposition, conditions of life) that influence the disease are, we can easily understand why the symptoms which a given treatment is to suit are so diverse in each case.

Nevertheless there are certain general measures, hygienic, dietetic, and medicinal, which should regulate treatment at the beginning, and in the further course of the disease may be variously modified according to the nature of the case.

A. DIETETIC TREATMENT.

Foremost stands the principle of eliminating as much as possible the carbo-hydrates from the nutriment. It is absolutely impossible to get rid of them entirely, as even purely animal fare, meat and eggs contains carbo-hydrates. Chemically pure albumen would have to be administered, which, however, would not maintain the bodily condition, let alone improve it.

The various forms of sugar—cane, fruit, grape and, milk sugar—are the most harmful. Inosite, inulin, and lævulose, which are also sugars, form an exception, inasmuch as, from experience, their consumption is not attended by any excretion of sugar in the urine. The same holds good for mannite, which, though sweet, is an alcohol and not a sugar. Practically these, together with glycerine, which is harmless to many, are readily used by many diabetics, while others do not find them a substitute for cane and fruit sugar. Honey, on account of its chiefly containing lævulose, may be allowed in moderation. All these sugar substitutes have been thrown into the shade owing to the discovery of saccharin a few years ago. This substance exceeds all other known kinds of sugar in sweetness some 300 times; very little is needed to confer the usual amount of sweetness to food and drink. At first, from its being difficult to dissolve, it was little used, now it has become general owing to its solubility being increased through combination with soda, and its cost being much reduced. All diabetics may take it without restriction. I have never been able to detect any injurious effect, either in digestion or in any other respect, but where from its great sweetness it may nauseate, it is better to dispense with it.

Next to sugar, bread and other farinaceous articles are most harmful owing to the abundance of starch they contain. The deprivation of bread is the most difficult to bear, for the patient can give up everything else, *e.g.*, farinaceous foods, confectionery, and sweet fruits, much more easily than bread. This great longing for bread must always be borne in mind by the physician.

For while the use of sugar and other carbo-hydrates can at once be stopped as soon as the diagnosis of the disease is confirmed, bread must only gradually be withdrawn. Even the most intelligent and strong-minded patients will declare they cannot go on without bread, and consequently often become refractory towards other prescribed measures. Every fortnight the amount of bread taken in 24 hours may be lessened by 50 grms. (about 1¾ oz.). If the patient was accustomed to consume daily 300 grms. (about 10½ oz.), in the course of two months it will have dropped to 100 grms. per diem (about 3½ oz.). If the amount of sugar in the urine is found to have decreased during this period to 1 per cent. or below, then the 100 grms. (circa 3½ oz.) may be continued for some time; but, with an increase of sugar the supply of bread must be still further reduced to a roll per diem, weighing 30 to 40 grms. (from 1 oz. to 1⅓ oz.), or, if necessary, bread must be forbidden altogether. By this gradual method the patient does not feel the loss so much. If the sugar diminishes in consequence of this line of treatment until traces only can be recognised, some months should be allowed to elapse before bread is resumed in the diet. It must then be given tentatively and with great caution. After a few grams of bread the urine should be examined two hours later, in the following days it may be slowly increased by a few grams until the limit of toleration for amylaceous food is reached. What holds good in the case of bread is equally true of other carbo-hydrates *i.e.*, those kinds of vegetables and fruits which we shall mention more succinctly later on. An examination of the urine after eating any of these is in fact the best indication of the amount of carbo-hydrates the patient may safely partake of without materially increasing the quantity of sugar excreted.

Instead of ordinary bread several substitutes have been proposed, either by freeing the flour from starch through washing (gluten bread), or by adding so much bran to the flour that the percentage of starch is greatly diminished (bran bread). An artificial bread may be prepared from lichenin (Icelandic moss) and its congener inulin, which have no influence on the excretion of sugar. Lastly, there is almond bread, made with almond meal, eggs, and fat, which is almost destitute of starch. The so-called Graham bread appears to be confused with bran bread, and is regarded as a bread substitute. It is, however, nothing but bread, made from fine wheat which has been coarsely ground (hence termed whole meal bread) without separating the bran. The meal simply retains the bran, the chief constituent being flour for all that, whereas in bran bread, the bran, to which only a small amount of starch unavoidably adheres, is the chief ingredient. This error appears to be pretty prevalent with the public, and hence it is never superfluous to mention this matter to the patient. All such bread substitutes are only useful in a small number of cases, partly owing to their insipidity, partly to their high price, and still more on account of their indigestibility. Usually patients give them up after a short time, and whenever I can, I avoid even mentioning them. Other cereals (rye, oats, barley, &c., and their various preparations) of course are just as harmful as wheat and its products. Next to these in point of starch contents come pulse, peas, beans, and lentils, then rice, potatoes, maize, sago, tapioca, arrowroot, and other tree and field produce, which are scarcely known by name in this country and need not be mentioned. Each and all are to be struck out of the dietary, as they contain from 50 to 80 per cent. of starch.

Of other vegetables generally used as articles of diet, the following must be avoided on account of their relative richness in carbo-hydrates: carrots, kale-turnips (kohl-rabi), horse-radish, garlic, onions, and celery. The following may be permitted in moderation: sour-kraut, cauliflower, broad-beans, turnips, mushrooms, truffles, artichokes, radishes and black radish (a large turnip radish). The following may be used in larger quantities: spinach, French beans, cabbage, lettuce and other greens used in salads (cabbage-lettuce, endive), watercress, seakale, gherkins, asparagus, and sorrel. The last must be avoided if oxaluria be present. Of the various kinds of fruits the following must be forbidden under all circumstances as the most harmful: grapes, melons, plums, figs, bananas, pears, chestnuts, peaches, apricots, and other sweet indigenous and foreign fruits. Strawberries, raspberries, currants, crab-apples, bitter cherries, oranges, almonds, and hazel-nuts in moderation may be allowed. Walnuts may be eaten with impunity.

As regards beverages, milk must be considered first and foremost. Milk contains all the elements of nutrition in the most compact and digestible form, which not only maintain the nitrogenous equilibrium of the body, but even considerably increase its weight, as is seen in the rapid growth of the suckling infant. To deprive diabetics entirely of so admirable a form of nutriment on account of lactose, as Cantani and others recommend, seems to me going too far. The amount should be limited to an average 120 grms. (about 4 fl. oz.) per diem, which will do the patient more good than harm. The following milk products are quite permissible: cream, butter, sour milk in which lactose has been converted into lactic acid, curds, and cheese, as well as koumiss and kefir. On the other hand, buttermilk and whey are not allowable. Tea and coffee may be taken as usual, with or without milk, and saccharin according to taste. The taste of unsweetened black coffee may be improved, according to some, by adding the yolk or the well-whisked white of an egg. Cocoa prepared from the nibs is harmless, but chocolate manufactured from the bean should be forbidden in toto. Lemonade unsweetened, or sweetened with saccharin, should only be taken in moderation and not allowed to touch the teeth, as these tend to decay in any case. Almond-milk and the various aërated, soda and mineral, waters may be used without restriction. The case is different with alcohol. The more or less pure forms of spirit, *e.g.*, cognac, rum, corn-spirit, slibowitz, whisky, brandy, &c., are considered by all to be harmful to diabetics, even when the quantity of sugar excreted is not thereby increased. The general condition of the patient decidedly deteriorates, and even the feeling of languor and loss of strength is not removed, by the administration of alcohol. With reference to wine opinions differ. Of course all wines artificially sweetened, French and other champagnes, Malaga, Tokay, Rust, &c., as well as those partially fermented and the sweetish fruit wines, should be rigorously excluded from the dietary.

Whereas some writers have noticed no injurious effect even after excessive wine-drinking, others have remarked just the contrary. This is after all not surprising, for, like the whole question of diet, it is solely a matter of individual idiosyncrasy. It is evident that if wine be allowed in moderation, in most cases it should be given tentatively at first, and those should be preferred which contain least alcohol and sugar. Therefore genuine Bordeaux and Austrian mountain-wines are more suitable than Port and Burgundy. Hungarian and Rhenish wines are generally somewhat sweeter, containing more than 1 per cent. sugar. Beer, which besides alcohol and sugar contains dextrin, should not be taken at all as long as sugar is being excreted. Should traces only be present, the patient may take now and then a glass of well-brewed beer (preferably Pilsen) and not too rich in malt. As for taking beer regularly, he must not entertain the idea for a moment. Thirst is quenched most satisfactorily by pure spring or well water, and with pieces of ice should polydipsia be distressing. Spices of every description (pepper, chillis, ginger, cinnamon, vanilla, and curry) should be cut down to a minimum. Salt, less harmful than any, should, however, be taken sparingly, as it increases thirst, which at all times is difficult to allay. If we cut off in this manner the supply of carbo-hydrates, the chief nutriment of the diabetic will consist of meat, eggs, and fats. Meat, moreover, is not quite free from carbo-hydrates; it contains small quantities of dextrin, maltose, and grape sugar, the influence of which is, however, completely counteracted in the body. The various kinds of meat of all mammals, birds, fish, amphibia, reptilia, and shellfish—turtle, crabs, lobsters, frog's legs, oysters, snails, &c.—may be taken, as well as the various organs used as food, brain, lungs, pancreas (sweetbread), kidneys, and spleen, except the liver, which contains sugar in the normal state. There is also no objection to the use of the various meat salts and extractives in the form of soups, broths, beef-tea, Liebig's extract of meat, and Leube-Rosenthal's solution of meat. It may seem superfluous to mention that in the preparation of various dishes, the customary addition of flour must be strictly avoided, still there are many persons ignorant enough in culinary matters who have no idea that dressed meat (baked fowl, baked fish, the so-called Viennese cutlets), as well as most vegetables, thick sauces,* and soups, are prepared with flour, and are frequently partaken of in blissful ignorance, especially in hotels and abroad. Hence the physician should make it a rule not to place implicit confidence in the assurances of his patient that he is dieting himself very strictly, but should always obtain from him what and how much he eats and drinks at the various meals, down to the minutest detail. Many a surprise and explanation will be in store for him! Next to meat, eggs, uncooked, soft or hard boiled, or prepared with butter, are most nutritious. As regards fat, in the earlier writings most divergent views are met with, some deeming it useful, others harmful. More abundant experience of later years has clearly proved that fat is exceedingly useful in diabetes, and in very many cases absolutely indispensable. Carlsbad physicians in particular, who prohibit the use of fat of every description to all other patients, as it disagrees with them while taking the waters, find to their surprise that diabetics can consume an extraordinary amount without interfering in the least either with digestion or with the treatment they are undergoing. I know some patients who actually had a great distaste for fat and rich dishes before they became diabetic, but now evince quite a strong desire for them. Some exceptions there may be, but these only prove the rule. In this question clinical experience has more claim to speak decisively than any theory, no matter how well based, that tries to prove actually in the digestion of fats glycerine is formed in large quantities, and consequently the excretion of sugar must increase. Moreover, fat possesses a valuable property, and one which cannot be too highly prized, of inducing satiety much more quickly than meat. The patient thus escapes the danger arising from eating too much meat and of overtaxing the digestive powers, producing loss of appetite. This latter may be fraught with peril to him; to preserve the appetite and digestion intact should ever be his main object.

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* Both these may be made tasty with yolk of egg and cream.

According to Seegen, sugar is formed in the liver from peptones and fat; if the body be deprived of fat, more meat will be required to form sugar, and, owing to proteid disintegration, emaciation would rapidly proceed, as is seen in the Banting system, where the diet is exclusively meat. Even obese patients benefit from the preserving property of fatty food, for they retain their *embonpoint* for a long time, which contributes to their peace of mind in no small degree.

As a rule from 150 to 200 grms. of fat (from ⅓ lb. to ½ lb.) may be taken with the food in 24 hours. In the majority of cases I do not consider it necessary at all to regulate the amount, but leave it simply to the judgment and taste of the patient. It should be seen that it is always fresh and sweet, and due regard should be paid to the digestibility of the various animal and vegetable fats (oils), which is by no means equal, and those should be chosen which from experience are most easily borne by the patient, *e.g.*, olive oil, fresh butter, pork dripping, and sardine oil. The various jellies prepared from cartilaginous and connective tissues, aspic brawn and the Hungarian Kocsonya, are quite harmless, and may be eaten without restriction. Mixed with a little vinegar and oil, diabetics relish them as an agreeable addition to fish and cold meats. It remains to be discussed as regards diet whether it is advisable to allow the patient to eat so much as to satisfy appetite or not. In this question again opinion has quite changed of late. For results have shown that the excessive diet of meat and eggs which patients were usually placed upon, gave rise to loathing and distaste, and from the greater difficulty in digestion caused dyspepsia with its sequelæ, besides increasing the amount of sugar. Now it is preferable to allow him to feel a little hungry, than satisfy appetite completely. However, to make him fast once or twice a week, as some propose, I consider cruel, and at the same time harmful to the patient. Frequent and small meals are most suitable, generally five are sufficient during the day, bearing in mind to vary them as much as possible. Culinary invention will find no difficulty in preparing for several days various appetising menus from the many kinds of meat and fish, from lobsters, crabs, oysters, eggs, aspic, and from the permissible vegetables, fruits, and beverages mentioned above.

Finally, every patient should make it a rule to eat slowly, take small mouthfuls, and masticate thoroughly in order that the influence of the saliva may be complete.

B. HYGIENIC TREATMENT.

Here again no hard and fast rules can be laid down, each individual should be treated most carefully according to the special necessities of the case. For instance, one of the most important hygienic measures, the methodical invigoration of the system, cannot be carried out in every case of diabetes. It is only in those cases where the temperature is but little below normal, cold hands and feet are not complained of, and where the constitution is naturally robust, that cold baths, douches, wet friction, and aëropathic treatment can be resorted to for their bracing effects. Where a tendency to furunculosis exists, any powerful stimulus to the skin must be avoided, *e.g.*, wet pack, a prolonged use of which will even in healthy subjects produce an outbreak of boils.

For the preservation of the skin, which may require special attention on account of its dry and harsh character, ordinary luke-warm baths, 26°—27° R. (90½°—92¾° F.), with perhaps a little mild hard soap, may be taken once or twice a week. The most scrupulous attention to the mouth and teeth cannot be too strongly insisted upon. Formation of aphthæ, sponginess of the gums, the great tendency to caries of the teeth due to acid secretions of the buccal cavity, may be best prevented by frequently rinsing out the mouth and throat with a lotion of chlorate of potash or of salicylic acid to which a little bicarbonate of soda is added. The teeth and gums should be brushed with a soft tooth-brush, and the interstices freed from any particles of food, which become so soon offensive. According to experience catching cold always renders the diabetic's condition worse; he clothes himself instinctively in thick garments, even in warm seasons, and during winter does not care to leave the heated room. The best protection against cold is after all the tone imparted by hydropathy. Those patients, however, to whom this treatment is inappropriate, or are disinclined to follow it, should spend at least several hours daily in the open air, *e.g.*, in light gardening, farming pursuits, hunting, fishing, riding, and driving, at first in fine weather, later on at all times.

The well-to-do may pass the winter in one of the Southern health resorts. Care must be constantly exercised in having the sitting and bedrooms well aired. Active muscular exercise is of very great value in those strong enough to take it; it always diminishes the excretion of sugar, and improves the general well-being of the patient. Any muscular over-exertion must be avoided, and extended intervals of rest from bodily as well as mental exercise should always be allowed. From experience, a long unbroken journey, especially when accompanied by worry and trouble of all kinds, is very detrimental as regards the amount of sugar excreted. To introduce regularity in work is best wherever possible. For weak and debilitated patients unable to work, passive movements and easy Swedish gymnastic exercises form a good substitute. In such cases massage is of special value, applied daily for twenty minutes. It is not necessary to strip the body, but all the muscles may be thoroughly, one by one, grasped, squeezed, and kneaded through a light garment. The discomfort after the first sitting disappears in the course of a few days. The effect of massage is strikingly beneficial and often has a very favourable influence on the excretion of sugar. It stands to reason that excesses of every description—pleasures of the table, sexual indulgence, smoking, gambling, as well as muscular and brain activity—must be most harmful, accompanied as they generally are by much excitement.

C. MEDICINAL TREATMENT.

Pharmacotherapy is far behind dietetic treatment in importance. Since we are successful in the slighter forms of diabetes —and these are the great majority—by means of withdrawing more or less the carbo-hydrates from the regimen, in causing the disappearance of the sugar and relieving most of the other symptoms, we really do not require any medicines, for they could do no more. Still, the withdrawal of bread and other carbo-hydrates is not a matter of no consequence, or indeed easily accomplished. An inestimable boon would be conferred on patients, if this restrictive treatment could be replaced by a medicament. But so far, unfortunately, none has been discovered. It is true, we know, that certain drugs are able to diminish the sugar, even with ordinary diet, still, either their effect is transitory or they are successful only as long as they are used, and, if persisted in, may seriously injure the health in other ways. The drugs whose effects are temporary are simply endless. There is scarcely a remedy in the old as well as in the new Pharmacopœias of every country which has not been tried by one or other physician, and pronounced efficacious, at least for a time, but even here superficial observation often went hand in hand with mistaken conclusions. One remedy gave way to another, and none remained long in the field. I need not allude to the older physicians and their blind empiricism, but even disciples of the new scientific school, who have been guided in their choice of drugs by theoretical considerations, have not fared much better—for instance, Cantani and his much-lauded lactic acid. As the sugar in the body passes directly into lactic acid, it appeared very reasonable to administer the latter instead of sugar, just as we endeavoured to lighten the work of the stomach in cases of feeble digestion by giving peptones. Experience, however, left the theory in the lurch—lactic acid proved to be more harmful than useful.

The antiseptics, phenol, salicylic acid, quinine, iodoform, the modern panacea antipyrin, and all the rest, fared no better. Even the powerful drugs strychnine, arsenic, pilocarpin, &c., have been long ago abandoned by most physicians, as their continued administration is an obstacle in itself. I find that an English physician, Squire, latterly has strongly recommended phosphorus ·005 to ·01 grm. ($\frac{1}{12}$ gr. to $\frac{1}{6}$ gr.) twice daily. Corrosive sublimate finds support from some author whose name shall not be mentioned, who without any justification regards syphilis as a cause of diabetes in the majority of cases. Let us hope he will not entertain this opinion too long. The administration of cod-liver oil, which was undoubtedly of great benefit in former times, has now become superfluous, owing to the admission of fat into the dietary. Hitherto only three remedies have stood in any degree the test of experience, and are most frequently prescribed. They are opium, morphine, and the alkaline waters which Carlsbad, Vals, Vichy, and Neuenahr offer. Opium, and still more so morphine, diminish the excretion of sugar with ordinary diet, at times completely arrest it, improve the nutrition and bodily weight, and cause the most troublesome symptoms to disappear, as long as they are administered, and even some time after they have been discontinued. Unfortunately, however, we are obliged to stop them after some months if we are not to make our patients opium-eaters or morphinomaniacs. Still, for a short period (4 to 6 weeks), or used alternately with alkaline waters and diabetic diet, they are extremely valuable, and in many cases indispensable. It is not yet explained whether they act by diminishing metabolism, or calming the nervous system, or have a specific influence over the disease itself. The great toleration of the two drugs is quite remarkable in diabetes. Incredibly large doses may be given without causing any of the usual drawbacks—obstinate constipation, drowsiness, and lethargy. Large doses can be given at the outset, opium 1 dcgrm. ($1\frac{1}{2}$), morphine 5 cgrm. ($\frac{3}{4}$ gr.), and they may be increased till treble the amount is taken at each dose morning and evening. However, as soon as the first symptoms of craving appear, restlessness, irritability, and painful sensations about the time usual for their administration, they must at once be stopped. As regards the alkaline mineral springs, Carlsbad stands first on account of its beautiful situation, its excellent arrangements for treatment, and the confidence which its old repute inspires in patients. It is undeniable that alkalies, in whatever combination, are sometimes capable of completely arresting, though only in the slighter forms of the disease, the secretion of sugar without resorting to anti-diabetic regimen. But in Carlsbad treatment almost always begins with placing the patient on rigid diet, and then gradually relaxing this until the limit of toleration of carbo-hydrates is reached. The inestimable value of this method consists in the period of toleration lasting much longer than with any other line of treatment. For once having determined the amount of bread, vegetables, and fruit the patient is able to take with impunity, provided he does not exceed this limit after the course of treatment, he may go on for some years, excreting either no sugar or but a small quantity, without feeling any the worse. This is not only the experience of Carlsbad physicians, but has been confirmed by the most eminent members of the profession in Germany, whence the largest number of patients come. For many reasons it is preferable that the waters should be taken at the springs; where this is not practicable the patient should order twice a year twenty to twenty-five bottles—either Sprudel, Schloss, or Mühl water—gently warm the water to 40° R. (122° F.) and take it according to the prescribed rules in Carlsbad. If the physician makes periodic and judicious changes in the use of these three powerful therapeutic agents—anti-diabetic diet, opium, and alkalies—he will be able in many cases to prolong life considerably. This line of treatment does not prevent attention to symptoms. Hence sleeplessness should be combated by sulphonal, chloralamid, excitement by bromide of potassium, neuralgia by antipyrin, &c. Electricity may be used in cases of impotence, spirit lotions containing salicylic acid in pruritus universalis, and local treatment must not be omitted in eczema and furunculosis, &c.

These are the leading features of rational therapeutics in Diabetes mellitus from the present stand-point.

ADDENDUM.

I greatly regret, owing to this paper being already in print, not to have been able to allude to the latest work of Seegen's "On Sugar Formation in the Animal Body." It only remains for me to refer the reader to this book, whose author has already gained great repute for his researches in Diabetes.

SYPHILIS OF THE NERVOUS SYSTEM.

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SYPHILIS OF THE NERVOUS SYSTEM.

THE pathology of the nervous system is one of the favoured children of our present-day medicine. Hardly any other branch of our studies from a condition of complete chaos has attained in so short a time so high a degree of development. If we compare the text-books of Marshall Hall and Romberg, both dating from the forties, and both standard treatises for their time, with the works of Erb and others of to-day, what a revolution there has been in something like forty years!

Histological investigation has gone hand-in-hand with experimental researches into the functions of the nervous system under normal and morbid conditions; new and more exact methods have promoted clinical study and given certainty to its results; and the therapeutics of the various affections has received an immense impulse through the perfection at which the physical methods of treatment have arrived.

Relatively the least positive advance has been made in ætiology, a fact which is explained by the great difficulties which surround the subject. These difficulties are particularly great when we come to consider the causes of diseases of the central nervous system. We must not, however, omit to notice that even on this line of investigation there are already several landmarks laid down which form the beginnings of a scientific treatment. I call to mind the important work that Déjérine lately showed has been done in regard to the influence of heredity on the origin of nervous disease; the investigations into the causes of general paralysis of the insane and of locomotor ataxia; the investigations into the effects of chronic lead poisoning and the abuse of alcohol and tobacco; and lastly, the researches into the influence which acute and chronic infectious disease may exercise on the nervous system.

We do not frequently see, as you know, disease of the central or peripheral nervous system follow from acute infectious disease. The nervous disturbances which result from enteric fever, puerperal fever, smallpox, measles, scarlet fever, and acute rheumatism are on the whole of rare occurrence; relatively the most common are the paralyses after diphtheria.

Of all infectious diseases syphilis is undoubtedly the most important in the present connection. Its causal relations to nervous disease have become during the last twenty years an object of continually increasing attention, and although in the conflict of opinion here and there there has been some shooting beyond the mark, yet we can no longer doubt that in the ætiology of this class of diseases syphilis is an element of great consequence. The multitude of important facts which recent times have brought to light, and the eminently practical character of the question, make it a duty for us all to study these things more carefully for our guidance both in diagnosis and treatment. Of course it must not be forgotten that we are often moving on uncertain ground, and that many, and those too the most important, questions are still matters of controversy. On this account the greatest caution is necessary in the interpretation of appearances, and in the estimate of their practical worth.

The historical development of the knowledge of the relation of syphilis to the nervous system may be summarised in a few words. It belongs wholly to our century, for what has come down to us from the 17th and 18th centuries represent conjectures rather than facts. As in other departments, so here also we can recognise very distinctly the absence of scientific verification in the eccentricities in which physicians of eminence indulged in their statements about these matters.

The whole question was first subjected to a thorough study by Virchow. His investigations referred chiefly to the late forms of syphilis in the periosteum, the cartilages, the bones, and the viscera. The particular character of the changes in the brain and its membranes, especially in the vessels supplying them, has been since determined by E. Wagner, Steenberg, Heubner, and others, not to mention Virchow himself. Eminent clinical teachers and neurologists in all countries have taken part in the further development of the questions at issue; besides E. Wagner, there are among others Westphal, Leyden, Erb, Mendel, Rumpf, Charcot, Fournier, and Clifford Albutt. To Rumpf especially we owe lately an excellent exposition of all that has been hitherto known, with the addition of a large number of new observations and discoveries. The question started by Fournier as to the causal relations between syphilis and locomotor ataxia has given rise to a very active discussion; and the connection between syphilis and general paralysis of the insane is a subject which is already represented by a literature of its own. I shall begin with consideration of Syphilis of the Brain.

Syphilis may make its appearance within the cranium in four different forms.

1. As syphilitic disease of the bones of the skull and its internal periosteum the dura.

2. As chronic syphilitic lepto-meningitis, in other words, as a true periencephalitis analogous to syphilitic perihepatitis.

3. As syphilitic disease of the arteries.

4. As syphilitic disease of the substance of the brain itself, infective granuloma. This appears either as a circumscribed gumma or as a more diffused infiltration of the brain substance.

The two last-named forms, syphiloma of the brain and syphiloma of the cerebral arteries, are not only by far the most common, but it seems generally occur in association. For the understanding of the multiform almost kaleidoscopic pictures presented by the symptoms of cerebral syphilis, this is of some importance.

Let us look first at the general features of these affections. Syphilitic disease either of the dura or pia is attended with the symptoms of chronic meningitis. The evidences are those of diffuse or circumscribed irritation of the membranes, combined with irritative disturbances of the cortical functions, with absence of localising symptoms. Taking precedence of all the symptoms is the violent headache which at times, especially during the night, becomes intolerable. Thereafter the other features of irritation of the cortex, sleeplessness, excitement, inability to think, weakness of memory, hallucinations, and illusions. Focal lesions may be added if the meningeal process penetrates into the brain-substance. This last-named occurrence, which appears to be not at all uncommon, will give rise, if at the base or in the motor areas of the cortex, to distinct motor and sensory derangements which may form a guide to the localisation of the lesion. Or, on the other hand, the hypertrophied tissue of the pia may gradually shrink, producing, if on the convex surface, lesion of the cortical centres, and if at the base, constriction of the cranial nerves. As far back as 1858 I drew attention to the occurrence of this kind of basal syphilitic lepto-meningitis. I published at that time in Virchow's Archives an observation showing how this variety comes to be of importance for the cranial nerves.

The case was that of a man 33 years of age, who had passed through an attack of syphilis a year before. With violent headaches there came on diplopia, ptosis on the left side, paresis of the right facial, paralysis of the palate, and difficulty in speaking. The examination showed complete paralysis of the left 3rd, the right 4th, the 6th on both sides, and the right facial, paresis of the right 3rd and left facial, and lastly paresis of the right upper extremity. Severe vertigo, staggering gait walking being only possible when he was supported on either side. Death from pulmonary phthisis followed.

The post-mortem showed considerable thickening of the pia at the base and constriction of the cranial nerves. With the microscope could be made out degenerative atrophy of those that had been completely paralysed, and partial degeneration of those that had been merely paretic. The olfactory, optic, trigeminal, hypoglossal, glosso-pharyngeal, and spinal nerves and the right vagus were intact. The brain substance showed nothing abnormal. No attention was paid at that time (1858) to the arteries.

Griesinger published an analogous case shortly after this one. While on the whole such instances as those of syphilitic periencephalitis are of rare occurrence, yet there are a number of recent clinical and anatomical observations which go to confirm my own and Griesinger's statements.

The diagnosis is determined apart from the history by the initial headache and the progressive paralysis of many of the cerebral nerves, especially the third; further, by the condition of the pupils and the reaction of the paralysed nerves to electricity. The result of antisyphilitic treatment may also give considerable aid, but if the case is far advanced, as the preceding was, our experience hitherto has been that this may not be of much assistance.

The syphiloma of the brain substance, a specific infective granuloma, pursues its course, on the other hand, with the features of a circumscribed cerebral tumour. The headache, the epileptiform convulsions, the monoplegic or hemiplegic pareses or paralyses, with subsequent spasmodic attacks in the paralysed muscles, the cortical speech-derangements, the condition of intellectual and mental weakness, and the apoplectiform attacks

—these symptoms warrant the diagnosis of a syphilitic cerebral tumour, if it is certain there has been previous syphilis, and if the patient is still young or not past middle life. Of course in a case like this the favourable result of antisyphilitic treatment afterwards is of great value for the confirmation of the diagnosis.

I would like, however, further to draw your attention to some general considerations which may be important in this connection. In a case of syphilitic disease of the brain substance, as a rule the symptoms are not so purely those of cerebral tumour as in other kinds of growth, for in addition to these we have those produced by the lesions in the vessels and membranes. Besides focal symptoms, therefore, we have disturbances in the circulation, in the sensations, and in the intelligence. Again, the epileptiform attacks are generally very severe, of long duration, and often followed by after-pain persisting for several days. Between the more serious attacks there may come numerous slighter fits of an apoplectic and epileptiform nature, pareses of single cranial nerves, attacks of giddiness or sensory disturbance, often only lasting for a moment, variations in the intensity of the headache and in the general motor and intellectual weakness.

When cerebral syphilis takes the form, not of tumour, but of syphilitic disease of the vessels, the diagnosis is more difficult. The importance of this arteritis luetica for the central nervous system becomes more evident the more thoroughly it is studied. Attention has only been turned to the affection during the last thirty or forty years, and we may perhaps consider the Danish physician Steenberg the proper discoverer of the connection of this form of arteritis with syphilis. Before his work, which appeared in 1860, isolated observations of disease in the larger arteries of the brain had indeed been published by Virchow, Dittrich, Bristowe, Graefe, and others; but Steenberg was the first to distinctly recognise the alterations in the vessel-walls as syphilitic and thus give a definite direction to the whole inquiry. Since then E. Wagner and his pupil Heubner have made a careful study of the finer structural changes in the vessel-wall, and it is especially to Heubner's work, which appeared in 1874, on syphilis of the cerebral arteries that this association, at once so interesting and so practically important, has been generally recognised.

The discussion on the point whether this specific process begins in the intima as Heubner thinks, or in the media or adventitia as his opponents suppose, has no great clinical importance. Of much greater consequence is the question as to what constitutes the specific character of the inflammation of the vessel-wall and of the syphilitic granulation tissue. That it depends on invasion by a parasitic infectious germ the pathogenic micro-organism of syphilis can to-day be no longer a matter of doubt. Microscopic evidence of such invasion has been brought forward in various forms, first by Lustgarten, then by Doutrelepont and Schütz, and finally by Disse and Taguchi, but the needful confirmation is still wanting.

The study of this syphilitic vascular change and its consequences has very great clinical significance. If we simply keep to the facts as they have been established we have the following: syphilitic arteritis leads to narrowing of the vessel-wall, and ultimately to its obliteration; the necessary consequence is limitation of the blood supply and diminished nutrition of the brain substance, and proceeding a step further, anæmic necrosis or white softening. These circulatory derangements are of the more serious moment that the arteritis has a special preference for the region of the great arteries at the base, especially the basilar and its branches. In this way the centres of vegetative life in the medulla and the great motor paths in the pons are in danger. At the same time we are not to undervalue the practical significance which attaches to the consecutive atrophy of the different layers in the wall of the larger arteries, especially the fenestrated membrane and the muscular coat. It is this atrophy which gives the conditions for the formation of aneurisms on the one hand, and for rupture of the arteries on the other.

It has been repeatedly asserted that this arteritis obliterans which occurs in the syphilitic brain is anatomically only slightly different from the endarteritis deformans of old age. As long certainly as we are unable to demonstrate the existence of the pathogenic infective germ of syphilis in the infiltrated tissue in the vessel-wall, to draw the anatomical distinction in any particular case, especially if it is far advanced, will be often a matter of difficulty. Clinically, however, the features of endarteritis deformans are as a rule very different from those of syphilitic endo- and periarteritis. In the first place, in syphilis the base and the cortex are preferred, while in senile endarteritis it is mostly the region of the distribution of the sylvian artery which is affected. There are no doubt cases in which, as we at present stand, it is impossible to draw a distinction between the two forms during life. Those well on in years who have contracted syphilis in earlier life are instances of this. In them thromboses or hæmorrhages in the neighbourhood of the sylvian fissure, or aneurisms of the basilar or internal carotid may occur, and without prodromal symptoms for any length of time quickly lead to a fatal issue. Prodromal symptoms going on for a long time have appeared to many to be elements of particular importance in the diagnosis of syphilitic vascular disease; and they are unquestionably of some value in cases occurring in younger individuals, but they cannot lay claim to much significance in those more advanced in years, for in the case of atheroma occurring in the latter long before the larger branches are completely obliterated we may have symptoms of ischæmia in regions supplied by the smaller twigs. These symptoms may completely disappear through establishment of the collateral circulation, but may again and again recur in the same or some other way, always, however, by preference in the region of the sylvian artery.

Valuable indications may be gained by the results of ophthalmoscopic examination of the arteria centralis retinæ and its branches. At any rate that is my deduction from an observation, which, in association with Dr. v. Hösslin and Surgeon-Major Seggel, I have had an opportunity of making on a patient of my own.

In this case, that of a robust gentleman of about 35 years of age, the diagnosis of brain syphilis was previously tolerably certain. Besides the history, we had the occurrence of severe epileptiform attacks, various pareses, &c. Intelligence and mental functions were quite normal. Complaints of disturbances of vision led to repeated examinations of the fundus by Surgeon-Major Seggel. The first examination about the end of the second week of treatment, showed thickening of the walls of the arteries, absence of the double contour in their outline, and a rather washed-out papilla. Ten days later, during which the mercury and iodide were continued, the double contour was again indicated, though the walls were still thickened and the papillæ were more distinct. After another ten days, during which inunction and internal administration of the iodide were continued with great energy, examination showed the thickening of the walls gone, the double contour even in the smaller vessels again distinctly visible, and the papillæ of perfectly normal aspect. The arteritic change therefore had regressed towards the end of the fourth week of treatment. At the same time the other symptoms had improved; more especially there were no further convulsive attacks, and the headache, which had previously been permanent, disappeared all but a trace.

Should it be shown that this ophthalmoscopic proof of the thickening in the arterial wall and its regression under specific treatment is constantly present in analogous cases, we should have a valuable aid where the diagnosis was otherwise doubtful; its presence at least would decide in a positive sense the existence of cerebral syphilis. Changes in the fundus have no doubt been previously described in cases here and there, but these have been instances, some of optic nerve atrophy (Laschkiewitsch), others of choked disc, with very dilated and tortuous veins. Fürstner's case (D. Archiv fur klin. Med., Bd. xxx.) was one of the latter kind, though no doubt there was general thickening of the vessel walls. Choked disc and optic nerve atrophy may, however, as you know, result from any of the very varied lesions which cause increased intracranial pressure or inflammatory and degenerative changes in the intracranial contents. In Fürstner's case, which Becker in Heidelberg examined along with him, the thickening in the vessel wall persisted up to the time of death. In our case it yielded to specific treatment giving in this way one reason for its diagnosis as syphilitic. For the future in all cases of brain syphilis the condition of the retinal artery should receive special attention throughout the whole course of the disease.

I have already mentioned the preference which syphilitic disease of the vessels shows for the great arteries at the base, especially for the vertebrals and basilar. The endarteritis deformans of old age occurs frequently enough in these vascular districts also, and in the circle of Willis, but does not readily bring about such a degree of disturbance of the circulation as the syphilitic disease. The significance which disease of the basilar artery has for the vital centres in the medulla is plain when we consider that the twigs going off from it are as Duret and Heubner have shown, mostly terminal arteries. Narrowing of these, or their complete closure, must of necessity lead to necroboisis of those centres on account of the absence of a collateral circulation. Putting aside the inferior and superior cerebellar arteries, the branches to the pons are particularly important. These go off from the basilar at a right angle to supply the pons and upper part of the medulla. Cases in which blocking of some of these branches has led to insular softening in the areas supplied have been repeatedly observed. There are, in particular, the cases in which the well-known pontine symptoms occur—difficulties in swallowing, in respiration, and in articulation, disturbances of the heart's action, and of the regulation of heat, polyuria, and alternate paralysis in the great motor paths. The whole complex of symptoms may appear at once, or they may follow one another, in either case without intellectual or mental disturbance. The cases of this kind hitherto known have had a somewhat chronic course, and most of them a fatal termination; while a few, with timely antisyphilitic treatment, have for the most part incompletely recovered. I may here put along with these cases one of my own. In this the symptoms developed themselves rather acutely with the features of pseudo-bulbar paralysis, and within a few days reached a height that threatened life. Treatment with iodide of potash produced speedy and almost complete recovery.

A journeyman locksmith, 29 years of age, acquired a hard sore in his 21st year during his military service. For this he had specific treatment for 14 days in hospital. He was again under treatment six months later for a skin eruption on the back. On the 15th May, 1887, eight years after the infection, he was seized with violent headaches, becoming worse at night. In the afternoon of the 17th May, sudden extreme faintness and violent ringing in the head. In the evening giddiness, diplopia, paresis of the right side of the body with numbness. In the course of the following day paresis of the right side increased, and in the evening complete paralysis. Then paræsthesiæ in the right side of the face, and difficulty in speaking; 24 hours after the latter began what he said could hardly be made out. No disturbance of consciousness. Admitted on the 20th May. On that day circulation hurried, respiration laboured, sensorium quite free. Right side of face paretic in lower half. Left eyeball imperfectly movable in any direction, rectus externus muscle completely paralysed, left pupil extremely contracted with hardly any reaction to light. Tongue moved with difficulty, trembling somewhat when pushed out; speech very difficult and scarcely intelligible; pursing of the mouth for whistling impossible; taste, smell, and hearing normal; arch of the palate paretic on left side, closure of the posterior nares in deglutition imperfectly produced, swallowing of solid food impossible; sensibility of the mucous membrane of the throat and entrance to the larynx distinctly lowered; epiglottis immovable and turned to the right; right vocal cord sluggish, left completely paralysed in the cadaveric position; staggering gait, inclination to fall backward, especially when eyes are shut; upper and lower extremities on right side very paretic; sensibility and electrical reactions normal, knee-jerk exaggerated, ankle clonus not elicited on either side. Old consolidation at right apex, herpetic eruption on left upper eyelid. On the 23rd, all the symptoms especially those connected with the circulation and respiration much worse. Condition in the highest degree threatening. From this day onwards had 45 grains of iodide of potash daily. By the 25th distinct improvement could be noted, especially in the speech and in the difficulty of swallowing. On the 26th, improvement in those two respects still more marked, and rather more power of movement in tongue and left half of palate. Paralysis of left external rectus and left vocal cord still complete. Ineffective coughing efforts followed by noisy inspirations; latter also present in laughing. In the next few days the ptosis in the left side disappeared, the anæsthesia and absence of reflexes in the mucous membrane of the throat and larynx and the paralysis of the extremities in the right side all improved. By the end of the month patient could walk about in the room without a stick; right leg dragged a little in walking, and strength for coarse movements in left upper extremity still subnormal. From the end of May to the beginning of July, when the patient by his own desire was dismissed, there was little further change in his condition though the iodide was continued throughout.

Patient was seen again on the 29th April, 1888, that is, a year after the appearance of the first symptoms. His condition then was as follows: left external rectus still paralysed. On the attempt to look to the left the eyeball is slightly rotated upwards; left pupil still distinctly smaller than the right, reacts slowly to light, rather better to accommodation for distance. Facial paresis is gone, whistling quite normal; tongue can be moved in all directions, but points slightly to the right when protruded. Speech still somewhat indistinct, slight slurring of the syllables, and after speaking for a time easily exhausted. Care is necessary in swallowing, and if it is quickly done he chokes himself. Sensory and reflex activity of mucous membrane of the throat and entrance to the larnyx still under the normal. Uvula turned to the right, arch of the palate standing a little lower on the left than on the right side, and in vocalizing movement on left side lags behind. Strength of the upper extremity for coarse movements not yet properly restored, but patient works the whole day at his employment as a locksmith. Arm can be lifted to the vertical position without pain. Right leg can be lifted, though with some effort, almost as high as the left. In walking right leg moves stiffly and drags a little with lifting of the pelvis. Fairly nourished, appetite good, no disturbances of sight or hearing. Still headaches brought on without any special cause, and with nocturnal exacerbations. These were very bad at the beginning of this year, and on that account he took to the iodide of potash again. No giddiness as a rule, but it comes on when he stands upon the slightest elevation (*e.g.*, even when he gets up upon a chair). No other pains complained of. Feeling in arm and foot normally acute.

The features of interest in this case are the rapid development and the great diversity of the pontine symptoms—paralysis of the left sixth, paresis of the left third, both facials, the hypoglossal, the glossopharyngeal, the inferior and superior laryngeal; hemiparesis of right half of the body; involuntary movement backwards, vertigo, headache. Of this group of varied symptoms, which developed within less than a fortnight, those which gave rise to most alarm disappeared under the use of iodide of potash in the course of a few weeks. There remained after that only the paralysis of the left sixth, a slight degree of left hemiparesis, and traces of the difficulty in articulation and deglutition.

The assumption is that the primary lesion in this case was a syphilitic arteritis, running a tolerably acute course, and affecting the basilar or its branches, together with all the consequences of such a lesion. This receives support from the variety of the symptoms referable to disturbances in both halves of the pons and medulla, with preference of the left half, and from the rapid success which attended the treatment by iodide of potash. We have a few similar instances recorded by Heubner, Leyden, Eisenlohr, Eichhorst, and Buttersack, some of which have been completed by autopsy.

Another case which came under our notice during life (already published by Dr. Rudolf v. Hösslin in the D. Archiv für klin. Medicin, vol. xxxvii.) had, besides other cerebral symptoms, great polyuria, and a course attended by fever.

A man aged 34 contracted syphilis in the camp before Paris in 1871. In 1885, 14 years after, he was seized—he said in consequence of an injury to the head (a scalp wound from a blow with an iron bar)—with the following symptoms: violent headache and sickness, fainting fits, followed by tremors, giddiness, staggering gait, especially when the eyes were shut, persistent fever of moderate height, and polyuria, the daily urine amounting to 210 ounces with sp. gr. 1002—1005. The only signs of syphilis were an old scar on the frænum and swelling of the cervical glands. After attempts with various remedies had been made in vain, iodide of potassium was given, and with this there was so manifest an improvement in the principal symptoms in the course of a week that, by way of clearing up the question, the administration of the iodide was then stopped. Immediately the headache, giddiness, polyuria, and fever returned. The diagnosis having been established by this experiment, the iodide was resumed along with mercuric inunction. The striking results of specific treatment on the polyuria and fever are very well brought out by means of diagrams in the article by v. Hösslin referred to. Four weeks after the antisyphilitic treatment was begun, patient was able to leave cured. As he was subsequently employed as an attendant in the hospital we were in a position to assure ourselves for a year afterwards that the recovery was permanent. Three years later, we have found on recent inquiry, he died of tuberculosis, unfortunately without a post-mortem.

In regard to the localisation of the intracephalic changes in this case we must—taking account of the giddiness, the staggering gait, &c.—place the vascular lesion in the basilar and superior cerebellar arteries, as these symptoms point to affection of the pons, medulla, and cerebellum.

A similar case, affecting a man about 40 years of age, came to a post-mortem lately, after having been under our observation for 2 years. In him also an attack of syphilis some years before had been followed by fainting and epileptiform attacks, difficulty in swallowing and breathing, staggering gait, at first with involuntary movement backwards and to the left side, and, to begin with, mental disturbance in the form of maniacal attacks, &c. The mental derangement disappeared under the use of iodide of potash, and the other symptoms improved, but only temporarily. Increasing motor weakness in the lower extremities made walking more and more difficult; the speech became harder to understand and the breathing more troublesome. Death resulted from pleurisy. The post-mortem, besides demonstrating the pleural effusion and considerable cardiac hypertrophy, showed the walls of all the arteries at the base of the brain greatly thickened, stiff, and gaping, the pons and medulla fallen in and soft. The microscopic examination, after the parts had been completely hardened, unfortunately miscarried.

If cases like those of brain syphilis, setting in with definite localising symptoms, can present difficulties in the way of a diagnosis, and can frequently be only rightly interpreted by the success of specific treatment, the difficulties are very much increased when we have only general symptoms to go upon. The occurrence of headache, giddiness, neurasthenic conditions, intellectual and mental weakness, but too often leave us in doubt, and usually it is only in the sequel, when localising symptoms occur, or a tentative course of iodide of potash succeeds, that the diagnosis is made certain. The difficulties are increased if the patient is up in years, if there is extensive atheroma, if there is present at the same time any cardiac or renal disease, if there has been previous neurasthenia, &c.

A question of great importance which forces itself on our notice here is that of the causal connection between syphilis and general paralysis of the insane. It has already produced a copious literature, but nevertheless is still very far from a settlement.

I may take it as acknowledged that the view of the disease as the product of a diffuse chronic meningitis and cortical mostly interstitial encephalitis, resulting in atrophy of the cortex, has been pretty unanimously accepted through the work of Mendel and others. I shall leave it undecided how far this view of its pathogenesis is generally justified, and restrict myself to the consideration of its connection with syphilis.

It was natural enough that the initial irritant for the interstitial degenerative inflammation of the pia and cortex should be sought in the infection of syphilis; and isolated statements were made a long time ago which as a matter of fact seemed to speak for the existence of such a causal relation. Of modern writers Mendel especially has supported this view. His statistics, which, embrace 146 cases of general paralysis, are really very convincing, as they show that in 75 per cent. of all paralytics secondary syphilis has preceded, and this does not take into account 8 cases of chancre which were not followed by secondary symptoms, and 9 cases with merely cicatrix on the penis. Alongside these figures referring to general paralysis Mendel places a set dealing with 101 cases of other forms of insanity. In only 18 per cent. of these could secondary syphilis be proved to have been an antecedent. The calculations of Rohmell, Snell, Reinhard, and others lead to similar conclusions. The opponents ot this view, like Westphal, Fürstner, Obersteiner, Goldstein, and others, give a smaller percentage, but even with them syphilis has preceded in from 25 to 50 per cent. of the cases of general paralysis, while in other forms of mental disorder it plays a much smaller part.

From these materials the conclusion may certainly be drawn that general paralysis of the insane is very much more common in those who have had syphilis than in those who have not. An attempt has lately been made to explain the connection by the hypothesis that the form of cerebral lesion depending on syphilis is not general paralysis but an affection resembling paralysis. Fournier, who was the first to express this view, has named the form pseudo-paralysis of syphilitic origin, and gives a number of differential symptoms by which such pseudo-paralysis according to him may be distinguished from genuine dementia paralytica. He notes specially the absence of the delusions of grandeur in the syphilitic pseudo-paralysis. While the majority of the French writers have supported Fournier, most of the Germans have protested against the separation of the two forms as artificial. Rumpf, in particular, has lately emphatically asserted that the delusions of grandeur are not absent even in the syphilitic form, so that the differential feature on which Fournier relies most would fall away.

In this way, then, general paralysis is distinguished essentially from all other mental disorders, that it is much commoner among those who have had syphilis than among those who have not. Now, the connection may be directly causal, or the syphilis may act in this case as alcoholic and venereal excesses do, as a predisposing influence, lowering the constitution and weakening especially the central nervous system. Which of these two suppositions is the right one we cannot at present decide.

As to the effect of anti-syphilitic treatment on general paralysis, it appears to have pretty nearly no effect at all. This has been adduced by many as a proof against the dependence of the paralysis on syphilis; but it really proves very little. The estimate of the results of treatment has to contend in this case with the same difficulties as in the case of tabes. In the beginning of the disease, when perhaps anti-syphilitic remedies may do good, the diagnosis is not certain; in the later stages, when the diagnosis is reached, these remedies have either no effect at all, or, at the most, we have the disease coming to a standstill, a result which pretty often occurs in paralysis with no drug treatment whatever. Furthermore, even in undoubted brain syphilis, especially in the later stages of extensive vascular lesion, anti-syphilitic treatment only too often is of no use. Coming to a definite conclusion, then, by the aid of therapeutic experiment is not so easy. Further investigations, let us hope, will bring light on these complicated questions. That they are of the highest practical importance is very evident.

I come now to deal with the syphilitic diseases of the spinal cord. These lesions are no doubt of much rarer occurrence than those of the brain and its membranes, though recent times have modified our views here also in more than one particular. Lesions of the spinal column and its periosteum, to judge from the small number of recorded cases, are among the greatest rarities. Syphilis of the dura, the arachnoid, and the pia appears to be somewhat more common. It occurs in the form of diffuse gummatous meningitis, the circumscribed gumma of the spinal membranes being rare.

The symptoms of syphilitic meningitis are those characteristic of chronic meningitis—spinal rigidity and tenderness, with root-symptoms, chiefly sensory, in the form of eccentric neuralgias and paræsthesiæ. When the anterior roots are affected, motor paralysis is a prominent feature; this possesses all the characters of atrophic paralysis. The absence of other spinal symptoms is, in a case like this, of great value, as shutting out disease of the cord substance itself. Of further importance for the diagnosis of syphilitic disease is the fact that, in accordance with their nervous supply, any muscle or group of muscles in the body may be attacked, the muscles of the trunk being affected as often as those of the extremities. The bladder and rectum may not escape. Anæsthesia extending over a wide area may be accompanied or ushered in by severe neuralgia.

In short, a picture of disease is presented which, with its combination of sensory disturbance with paralysis and a high degree of atrophy of numerous muscles, can be recognised as something quite peculiar. Of course differences in the longitudinal and transverse distribution of the morbid process can give very great variety to the features of the disease in different cases. Instead of any further description I will give an account of a case that came under my own observation. It is instructive in every respect, and especially in this, as proving that in even apparently desperate cases of the kind life may be saved by timely and energetic specific treatment.

The case was one of a merchant, 37 years of age, in comfortable circumstances. After I had examined him in his own house he was admitted, on my direction, into a private room in the hospital in February, 1881, with the diagnosis, "syphilitic cerebro-spinal meningitis."

Patient had a chancre in 1862 followed by buboes, and afterwards a skin eruption. Treatment with sulphur baths got the better of the latter after it had persisted for half a year. In 1872 he had a vesicular eruption in the neck, which he said disappeared after eight days. In the last year or two rheumatic pains coming and going in the shoulders and legs. In April, 1880, suddenly seized with severe pains down the whole left side, worst in the abdominal and lower thoracic region. In June a feeling of numbness round the body. In August and September remission of pains and onset of anæsthesia over the whole left half of the trunk. In October severe headache, especially in the brow, and pains in all the muscles of the body, worse at night. In December a sudden sensation that his face was divided into two, then diplopia and left-sided ptosis. Eight days later pains in the left shoulder, followed by weakness of the left upper extremity, which in a few days gave place to complete paralysis. About this time also loss of sensation in the right half of the mouth and nose, so that patient was obliged to chew on the left side, and in snuffing had no sensation in the right nostril. Soon after this the right arm became weaker, and the hand on that side numb. Towards new year weakness in legs to so marked an extent that patient could no longer go without support. Further, he noted complete loss of the sweat secretion on the left side of the face, and distinct diminution of it over the whole left half of the body. Bladder and rectum intact. Intellectual and mental condition normal.

On his admission into the hospital he was very emaciated. Skin loose and muscles extremely flabby, and everywhere wasted to about the same extent. Upper eyelid drooping, left eyeball almost quite immovable, only slight rotation outwards and downwards still possible. In right eyeball external rectus completely paralysed. Left half of the forehead smooth, left naso-labial fold partly obliterated, mouth drawn a little to the right, tongue protruded towards the left. Symptoms in the muscles of the trunk are very striking. The left half of the thorax is quite immovable in respiration, the upper intercostal spaces exposed in consequence of the atrophy of the pectorals, and deeply retracted. Muscles in the left side of the abdomen also paralysed completely in the upper half, incompletely below. Patient unable to raise himself from the recumbent position. Over the lower intercostal spaces on both sides, but more markedly on the left, there is a horizontal furrow moving downwards in inspiration, upwards in expiration (visible diaphragmatic motion). In forced expiration the muscles on the right side of the abdomen contract fairly well; on the left side below very weakly, and above not at all, so that at each coughing impulse, the left mesogastrium and hypochondrium bellies out to the size of a child's head, and at the same time the lower opening of the thorax is very much dilated. Active and passive movement of right upper extremity possible in all directions; strength, however, for coarse movements at a minimum. Pressure of the hand scarcely perceptible. Left upper extremity very much emaciated, equally so all over, and almost completely paralysed. Resistance to passive movements in the joints. Deltoid, supra- and infra-spinati, latissimus dorsi, pectorals, and serratus magnus paralysed and extremely wasted, muscular substance scarcely to be felt. Points of the fingers can be inserted between the acromion and head of the humerus. Head turned to the right, cervical spine curved to the right, dorsal spine, by way of compensation, to the left. Left scapula approximated to the spine, and fixed in this position on account of contracture of the rhomboids, trapezius (middle and lower portion), and latissimus dorsi. Legs paretic; muscles very thin and soft, especially of left leg. Patient can walk with the support of two persons; feels himself safer when on the left leg than when on the right. Strength of muscles for coarse movements everywhere very much diminished. Dorsi-flexion in the right foot very limited. Left knee-jerk absent, right much exaggerated. Ankle-clonus absent. Cremasteric reflex prompt. Skin reflexes exaggerated, tickling plantar reflex very marked. Tactile conduction normal, pain conduction prompt. Sense of space on the right side moderate, on the left distinctly defective. On the left side of the abdomen and thorax almost complete analgesia and anæsthesia, incomplete in the left lower extremity. Skin of the left inguinal region and of the penis and scrotum rather hyperæsthetic. On the right half of the abdomen and thorax sensibility normal, normal also on the left half of the face and tongue. No hyperæsthesia in the skin of the extremities on right side. Of trophic disturbances in the skin all that could be seen was on the fingers of the left hand, and on the left foot, where there was a marked hypertrophy and desquamation of the epidermis; none of this on the right side. The sweat secretion, diminished in the left half of the body since the end of December, has now for a short time been absent altogether on that side; normal or even exaggerated on the right side of the face and thorax. This observation was repeatedly verified by means of pilocarpine injections, when the left half of the face remained quite, of the body almost quite, free from perspiration. Electrical examination of the paretic and paralysed muscles gives simple diminution of irritability to both kinds of current, more evident on the left than on the right. In the completely paralysed nerves and totally atrophied muscles of the left arm and shoulder and left half of the abdomen this has gone on to complete loss of reaction to either current. No trace of the reaction of degeneration. K. Cl. C. everywhere greater than A. Cl. C. Lightning-like contraction in the paretic muscles. Idio-muscular contraction easily brought out in the atrophied muscles. Of subjective sensations patient complains of a feeling of extreme muscular weakness all over, a feeling of numbness around the body and in the left thigh, at times cramps in the left lumbar region, and on one occasion pain in the left shoulder. Otherwise he was free of pain. Appetite good and bowels regular, always free of fever, and in good spirits.

On the 10th March patient left the hospital essentially improved, having used over 1¾ ounces of iodide of potash and nearly 2½ ounces of mercury ointment. In all the paralysed muscles traces of contractility were showing themselves. Even the left upper eyelid could be lifted a little, though always with the help of the frontalis muscle. The unilateral sweating on the right side of the face was still present. In the following weeks, under treatment at his own house, he made tolerably rapid progress, and from the middle of April onwards patient was engaged once more in his business.

It is of the greatest value to keep striking cases like this under observation over a long period. Unfortunately we know from experience that severe cases of cerebro-spinal syphilis, almost always in a longer or shorter time, and in spite of the most skilful and energetic treatment, relapse, and ultimately succumb to the malady. It was thus specially interesting to follow up this instance of relative recovery from an unusually severe attack of the kind. The patient, at my request, willingly allowed himself to be visited again in April, 1888, eight years after the illness. The result of my examination surprised me in more than one particular.

His general condition is in every respect satisfactory. He is engaged in his very extensive business from morning to night, mounts stairs without difficulty, and walks for hours at a time. He is in a restaurant for several hours every evening, eats largely, and drinks freely both of beer and wine. But in spite of this capacity for exertion, the examination brought to light many and serious traces of the illness he had passed through. The head is now held upright. The spinal column, however, with the whole trunk, has a bend to the left, and on account of this he has worn for some years a corset with arm supports, which he finds very useful. The spine is not tender to touch, though this has been the case only for a year past; before that it was "sore" on touching. In the legs the muscles are strong and the movements normal. The lower margin of the costal framework is pushed a little forwards on the left side. The whole left half of the thorax is immovable both in ordinary and deep breathing. In coughing the left lower thoracic and left upper abdominal regions are strongly pushed forward. Abdominal and thoracic muscles in left side, also muscles of arm, especially upper arm, on the same side are thin. Left deltoid moderately atrophied, and shoulder joint almost completely anchylosed. On this account arm can only be raised to the horizontal position, and its muscles and those of the hand are less capable of work than those on the right side. Facial mobility on the left side is again quite normal, and the play of features very lively. Paralysis of the left third still persists in part, the movements of the eyeball upwards and downwards being very limited, inwards rather better. The ptosis is gone. Function of the right external rectus almost normal. The left pupil is rather smaller than the right; both react sluggishly. Patient wears a dimmed glass in front of his left eye, as the double images standing on different levels are a source of great annoyance. When his spectacles are taken off these images are at first scarcely noticeable, but gradually they separate, the separation being produced by the image for the left eye moving upwards and to the left. Apart, however, from the effect of the double vision, patient walks unsteadily, easily stumbles on the level ground, and has to be very cautious, especially in moving round. After over-exertion in walking or stair climbing he easily gets cramps in the muscles of the thighs and calves, very markedly in the peroneal muscles, also in the quadratus lumborum and abdominal muscles. These cramps are sometimes more on the one side, sometimes on the other. Up to two years ago walking for any length of time brought on sudden attacks of diarrhœa, or even involuntary motions of the bowels, and under the same circumstances sudden desire to pass water with involuntary action of the bladder if the desire could not be given effect to. Also passed water during sleep. During the last year or two these vesical and rectal troubles have ceased. Some ataxia; standing with the eyes shut produces unsteadiness; knee-jerks quite gone; sensibility over the left foot nearly normal, tactile distance in the toes being 12 millimetres. Complete anæsthesia in the left thumb. Cutaneous sensibility in the left arm and left side of the abdomen and thorax still markedly deficient. Over the front of the left thigh distinct anæsthesia. Over the left side of the face, where at first there was complete anæsthesia, sensibility is now quite normal, but the secretion of sweat is not restored. Sexual functions, which at first were retained, have completely disappeared for almost seven years. Urine normal in quantity and free from albumen and sugar; can be kept for any length of time. Appetite and bowels always normal.

This case—a typical picture of syphilitic cerebro-spinal meningitis with multiple root-neuritis—showing in its features a remarkable agreement with those of Buttersack (Archiv f. Psychiatrie, xvii. p. 603) and Kahler (Prag. Zeitschrift f. Heilkunde, 1887, 1), both of which ended fatally. Affection of the substance of the pons and medulla was from the very first by no means out of the question. But the chief element was the atrophic paralysis arising from the lepto-meningitic root-neuritis. In our case this had reached a greater degree and a more extensive distribution than has ever previously been recorded, at any rate in instances where recovery followed. This gives quite a peculiar value to the observation, for it shows the extent to which the lesion may go, and yet be capable of relative cure if an energetic antisyphilitic treatment is commenced in time, and further, it teaches that such cures may be permanent. That the cure may fall short of being complete is merely the rule enforced by all previous experience.

The subsequent development of a kind of atypical tabes is particularly interesting. The symptoms were, some degree of ataxia, absence of the knee-jerks, impotence, and partial immobility of the pupils.

Such cases of syphilitic cerebro-spinal meningitis with multiple root-neuritis are quite easy to diagnose. The flying pains at the commencement, the rigidly upright position of the spine, the symptoms indicating implication of the base of the cerebrum, and the spinal roots, are all characteristic enough. More difficulty arises in the differential diagnosis between a circumscribed spinal meningitis, for example, meningeal gumma, and syphilis of the vertebræ, as in the latter case also we have local tenderness and rigidity of the spinal column. A swelling of one or more vertebræ with local tenderness probably always means syphilis of the vertebræ, but of course if the growth is in the vertebral canal there may be no swelling. We must, besides, not overlook the fact that gummatous periostitis in the vertebral canal may set up a morbid process in the meninges, and finally even in the substance of the cord itself. But these syphilitic lesions in the spinal canal are under any circumstances not common, and of the various localisations here under review syphilis of the vertebræ themselves seems to be the rarest.

Our knowledge of syphilis of the substance of the spinal cord is little more than in its first beginnings. In the few cases that have been accurately examined histologically we have the arteritis with the thickening of the vessel wall going on to obliteration, the multiplication of nuclei in the adventitia, and the cellular infiltration in the perivascular lymph-spaces. Professor Bollinger recently demonstrated to us some very instructive preparations showing these vascular changes from a case that had died of somewhat acute cerebro-spinal syphilis.

But such changes appear to be by no means so common in the cord as in the brain; and the discovery and proper estimate of them during life is certainly often attended with great difficulties. For the differential diagnosis Rumpf lays most stress on this, that syphilitic myelitis has no tendency to produce purulent breaking down or softening, as is the case with transverse myelitis, and that accordingly the clinical features of syphilis of the cord correspond more to those of a tumour than to those of a transverse myelitis. We have chiefly the symptoms of such irritation as attends only partial destruction of the conducting power of the cord, excentric neuralgias, spastic phenomena, cramps, along with some degree of paralysis. But in each individual case we must have present other late forms of syphilis, or evidence that there have been such formerly, before the syphilitic nature of the myelitis is regarded as proven.

Of surpassing importance appears to be the part which syphilis plays among the causes of locomotor ataxia. Fournier in 1876 was the first to express the opinion that locomotor ataxia in the majority of cases was due to syphilis. After him Berger and Erb in Germany lent substantial support to the view by the results of their extensive inquiries. Erb especially, in a series of publications, has exhibited the causal relationship between syphilis and locomotor ataxia as statistically proved. The statements of these authorities have been confirmed by the experience of a number of trustworthy observers, as Gowers, Benedikt, Erlenmeyer, Reumont, Voigt, and Rumpf. The other side of opinion is represented by Westphal, Leyden, Remak, Lancereaux, and Althaus, who have expressed themselves as for the present against the connection. The differences between the figures of individual observers are very great and at present inexplicable. Erb, whom we may certainly call a cautious and trustworthy investigator, basing his statements on the carefully recorded histories of 100 cases, gives 91 per cent. of them as preceded by chancre and syphilis, secondary syphilis having certainly occurred in 61 per cent., and chancre, without proof of constitutional syphilis in 20 per cent. Only 9 of the 100 cases had no specific history. Alongside these numbers Erb places those giving the occurrence of chancre and syphilis in 1,200 individuals with no tabes. 10·25 per cent. of them had had syphilis and 12·5 chancre alone. Fournier also gives the percentage in ataxies as 91, Althaus as 86·5, Voigt as 81, Bernhardt and Eisenlohr each as 60, Rumpf as 70. In all these numbers syphilis and chancre are reckoned together. My own observations in hospital and private practice since I have paid precise attention to this point in each individual case give 71 per cent. of syphilis and chancre combined as preceding the ataxia. On the other hand no doubt there are many authors who only make out from 30 to 40 per cent. At the very least we can certainly say, what even the opponents of Fournier's and Erb's theory must grant, that there is a causal relationship between syphilis and tabes. Whether the former is the direct or only the predisposing and auxiliary cause of the latter must, as in the case of general paralysis, remain for the present undetermined.

The anatomical changes in sclerosis of the posterior columns so far as they are yet known give no handle for any estimate of the causal relationship, nor do the effects of specific treatment. The result of the use of both mercury and iodide of potash in ataxia is in general very unsatisfactory, though cases of undoubted improvement and even recovery have been related by such competent observers as Erb, Berger, and Rumpf. It must be borne in mind, however, that most cases of locomotor ataxia come under treatment at a relatively late period, and that while they certainly as a rule not only do not improve but even get worse with iodide of potash and mercury it is possible that good results might have been obtained in the initial stages.

But any estimate of the results of treatment in tabes is rendered uncommonly difficult on account of the spontaneous improvements or pauses as regards both the general progress of the disease and the individual symptoms which occur under any treatment or none at all. Instances occur of suspension of the progress of the affection for ten, fifteen, or thirty years, even of its coming to a full stop. I have myself seen, and still have under my eye, cases of the latter.

It is therefore impossible at present to be certain about the causal relation between syphilis and locomotor ataxia, and we can perhaps hardly expect the matter to be cleared up until both our diagnosis and our treatment are under the guidance of pathological histology, and a knowledge of the pathogenic micro-organism of syphilis. At present we can only say this much, (1) that there is a causal relationship between syphilis and locomotor ataxia, and (2) that the treatment of a case of locomotor ataxia on antisyphilitic lines is only indicated in the initial stage of the case, and where there is no doubt about the syphilitic infection.

We come finally to consider syphilitic disease of the peripheral nerves. That there is such a thing is beyond doubt, and the occurrence of a syphilitic neuritis seems to me to be even commoner than we have hitherto assumed. The microscopic examination of nerve trunks affected with this neuritis shows the same changes as characterise the specific disease of the central nervous system—the peculiar vascular changes, proliferation of nuclei in the lymphatic sheaths, formation of swellings by means of infiltration of granulation cells into the perivascular lymph spaces, absence of the tendency to degenerate, breakdown, or suppurate, rather a steady persistence of the condition of irritation, eventually regression with hyperplasia of the connective tissue and cicatricial shrinking. The clinical features may be gathered from this description—an obstinate affection with persistent symptoms of irritation and moderate disturbance of function.

The most usual form is syphilitic neuralgia from neuritis of sensory and mixed nerves. It may occur in any nerve, but the trigeminal and the sciatic are the commonest seats. It occurs along with other syphilitic processes, especially with specific periostitis of the skull, or with disturbances in the ocular muscles, pupil, &c. In this way it is of great importance in a case of obstinate sciatica, in one who has had syphilis or is yet syphilitic, to note the occurrence of ptosis, paralysis of ocular muscles, any difference in the size of the pupils, or absence of the pupillary

PROGRESSIVE
MUSCULAR DYSTROPHY.

BY

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PROGRESSIVE MUSCULAR DYSTROPHY.

GENTLEMEN,—

We owe the notion of progressive muscular atrophy to the descriptions of Aran[1] and Cruveilhier[2] and above all to the incomparable clinical powers of Duchenne[3]. The disease they introduced us to under that name—a chronic, insidious, slow, general muscular wasting—has in its various forms kept up its interest for pathologists to this day. Nor has the conflict of opinion about these forms come to a halt. In our own day, in the last ten years, this interest has shown itself in the most lively way in a series of recorded cases and publications. New ways of looking at the facts have been proposed, new opinions have been formulated and actively discussed. These discussions appear to have essentially advanced our knowledge, clearing up, and in part reconciling the various mutually hostile views.

To begin with, there were considerable differences of opinion about the nature and proper seat of the disease. One party (Aran, Duchenne, Friedberg) explained it as a primary muscular lesion, while another (Cruveilhier, L. Clarke, R. Remak, Eulenburg and Guttmann, and others) held that it was a disease taking origin in the nervous system—spinal cord or sympathetic. Gradually, however, under the influence of the French school, aided by a happy series of clinical and anatomical observations (Luys, Hayem, Charcot and Joffroy, Duchenne and Joffroy, Charcot and Gombault, &c.), the theory of the spinal origin gained ground. By Charcot[4] in particular the theory was developed in an attractive and convincing way, and chronic degeneration of the anterior horns of grey matter with disappearance of the large multipolar nerve-cells was laid down as its primary cause.

But this view did not remain uncontradicted. It was very energetically opposed by Friedreich, who in his well known monograph[5] (1874) defended the myopathic origin with great learning and acuteness; according to him the disease was a chronic inflammation of the muscles, a chronic progressive polymyositis. But Friedreich's weapons were not sharp enough; he based on a series of cases that was sadly in need of proper sifting and contained a good deal that was foreign to the subject, and his microscopic work was not equal to the requirements even of that time. So the triumph of the neurotic theory was temporarily assured, and the practical unanimity with which it was accepted is evident from Kussmaul's essay[6] in the present collection (No. 54, 1873). Even the very remarkable and now thoroughly understood case published by Lichtheim[7] in 1878 made no change in public opinion.

During all this time, of course, "progressive muscular atrophy" was accepted as a clinical unity, and though much was taken from it as not belonging to it, yet there was a very distinct tendency to extend its limits in various directions. The pseudo-hypertrophic paralysis of children, which had been first described by Griesinger and afterwards more exactly by Duchenne, and which certainly at the first glance appeared to be far enough removed from it, was even by Friedreich brought into association and viewed as essentially identical with it. Leyden[8] (1876), however, with true clinical instinct, in his treatise on Diseases of the Spinal Cord, made a proposal to separate from the rest under the term "hereditary" certain forms of progressive muscular atrophy which occur in families. He gave, though with insufficient exactness, the clinical features of the variety, and even then directed attention to a certain likeness which it bore to pseudo-hypertrophic paralysis. Moebius[9] (1879) went still further, and without any hesitation brought the latter, the pseudo-hypertrophic form, which also frequently occurs in families, into one group with Leyden's. But these views failed at first to find general acceptance, evidently from the fact that neither clinically nor anatomically were they laid down with sufficient precision.

In the meantime the advance in the study of the nervous system had succeeded in separating from progressive muscular atrophy the following: the results of acute anterior poliomyelitis, the chronic forms of poliomyelitis, chronic multiple neuritis, the atrophies following joint affections, syringomyelia, and the various secondary spinal amyotrophies. With all this curtailment, however, there was still a residuum of considerable importance included under the apparently one and undivided progressive muscular atrophy. At that time (1883), grounding on numerous cases of my own I made an attempt[10] to show that this apparent unity contained at least two clinically and probably anatomically different forms of disease, and that these were clearly distinguishable throughout in symptoms, development, localization, and actual condition of the tissues. By the side of the well-defined spinal form, which depends on lesion of the anterior horns of grey matter, I placed another, which I called "juvenile" muscular atrophy, and I sought then to show in detail that the pseudo-hypertrophic paralysis and the hereditary form of Leyden both belong to the latter type. Looking at the matter in this way, and with the light thrown upon it by Lichtheim's case, it followed that probably we had in these latter forms not a spinal affection but a purely muscular lesion, in which the nervous system, more particularly the spinal cord and the peripheral nerves, appear to be quite intact. Thus the view maintained with such obstinacy by Friedreich was recognised as having at least partial justification.

The separation of the two forms which I proposed, and which I arrived at exclusively from the observation of living cases and from carefully noting the differentiating features, met shortly with almost universal acceptance. It was of especial value that Charcot and his pupils at once and unreservedly closed with my view and proceeded to give it greater breadth and its foundations greater firmness. Shortly afterwards Duchenne's "infantile" muscular atrophy, on which I had not touched and whose essential criterion is commencement in the face, was recognised by Landouzy and Dejerine[11] as a primary myopathy, the central nervous system remaining normal; after some little reluctance they associated this also with my juvenile and with the pseudo-hypertrophic form. The results of some more autopsies in cases of juvenile muscular atrophy (Fr. Schultze,[12] Landouzy and Dejerine, P. Marie) contributed in no small degree to the establishment of the theory, and additional progress has been made through the large number, partly of recorded cases and partly of careful anatomical and clinical studies, which the last year or two have produced (Zimmerlin, Fr.

Schultze, Marie-Guinon, Edgren, Frohmaier, Penzoldt, Hopmann, Singer, Ladame, Hitzig, Sachs, Westphal, F. Raymond, and many others). Through all these more recent works, with few exceptions, there runs as a fundamental supposition the view that the way in which I have put this matter is completely justified, and, although many of the details are still subjects of dispute, and many important questions still await solution, we are now standing on clearer and firmer ground than we did fifteen years ago.

Allow me now, gentlemen, to bring before you to-day some cases by means of which you can form a judgment of your own:

1. You have here a young man, twenty years of age, Theodor Brandt. He works in a brewery, and has sought our help on account of increasing weakness and emaciation in his arms and legs. He is the youngest of twelve children, and an elder brother suffers, it seems, from the same trouble. The affection commenced gradually, in his seventeenth year, with weakness in the arms and legs, falling in over the region of the pectoral muscles, and wasting of the upper arms. He has never had either pains or paræsthesiæ, and is otherwise perfectly well.

You see before you a strongly-built man, in whom at first the only thing that strikes you is the great slenderness of the upper arms as compared with the forearms and shoulders, and the abnormal position of the shoulder blades. If you examine more carefully, you will find very extensive, and in part extreme, *atrophy* and weakness of a large number of the muscles in the trunk and upper extremities.

These are as follows: the pectorals (especially in the middle, and lower bundles, the clavicular portions being in parts untouched); the trapezii (almost completely disappeared); the latissimi dorsi (on the right side almost completely gone, on the left all but a slender bundle of fibres on the anterior edge); the serrati magni (especially on the right side); rhomboids (only partly, and in moderate degree); sacrolumbales and longissimi dorsi with their continuation in the neck (largely disappeared); bicipites and brachiales antici (on the right side extensive atrophy, moderate on the left); supinatores longi (on both sides wholly gone); and tricipites (on right side extreme atrophy, moderate on left).

These atrophied muscles contrast strongly with the following, which are *well preserved*, or even distinctly *hypertrophied:* sterno-mastoids and splenii (normal and well developed); levatores anguli scapulæ (slightly hypertrophied); deltoids (in the lower part on left side distinctly hypertrophied, firm and hard, in the upper part rather atrophied; on right side throughout more atrophied, but in the lower part still hard and firm); supraspinati (strongly developed); infraspinati (on both sides distinctly hypertrophied, very hard and firm); teretes majores (on both sides rather thin); coracobrachiales (very powerful and well developed); flexors and extensors in the forearm (on both sides normal throughout and very strong); and the small muscles of the hand (all of them normal and acting well). The facial muscles also are perfectly normal.

The upper arms are from 2 to 4 cm. less in circumference than the forearms. The forearms in the upper part are rather more cylindrical in shape than usual.

In the lower extremities there are very few changes to be made out; the thighs are almost quite normal, perhaps the tensor fasciæ is a little wasted. In the legs there is distinct weakness of the peroneal region on both sides, especially in the tibialis anticus muscle, which on the right side is also a little atrophied.

The recti abdominis are in good condition, and acting well, but the flat abdominal muscles are distinctly weak, and when the head is raised up from the lying position swellings of elastic consistence make their appearance in the sides of the abdomen. Muscles feel for the most part rather soft, but are nowhere tender. No fibrillar twitchings. Mechanical irritability in the affected muscles is everywhere distinctly lowered, especially in the peroneal region (tibialis anticus). Electrical irritability everywhere more or less lowered, especially to direct stimulation; no qualitative change, and nowhere even an approach to the reaction of degeneration.

Sensibility perfectly normal. Skin reflexes normal, tendon reflexes absent in the upper arm (triceps and biceps), present in the forearm, active in lower extremity.

Head, cranial nerves, special senses, internal organs, all perfectly normal.

Here, gentlemen, you have a typical picture of the disease which I have described under the name of juvenile muscular atrophy. The case is in the medium stage of development.

Turn your attention now to this next patient.

2. Max Mudrak, a locksmith, twenty-two years of age, apparently of a healthy family, among whom no affection of a similar nature to his own has been observed.

Began his apprenticeship at fourteen years of age, and was obliged to work very hard. Not long after this his shoulder-blades were observed to stand out in a peculiar way, and by the time that he was eighteen this was very noticeable. From his twentieth year onwards felt his work harder on him, and observed that his right upper arm was getting thinner. Now it is only with some trouble that he can, "with a jerk," raise his arm to the vertical position. Lately great exhaustion in his legs and sometimes in his back. Has never had pain. Has had frequently migrainous headache ever since his schooldays. Otherwise quite healthy.

If now, gentlemen, you will take a look at this man, you will see that he is of middle height and well built. He strikes you at once by the following peculiarities: the neck is very broad, the shoulders very sloping, and the shoulder-blades standing out; in contrast with the enlarged deltoids and sturdy forearms his upper arms are remarkably thin; there is slight lordosis of the lumbar vertebræ, and his lower extremities are very large.

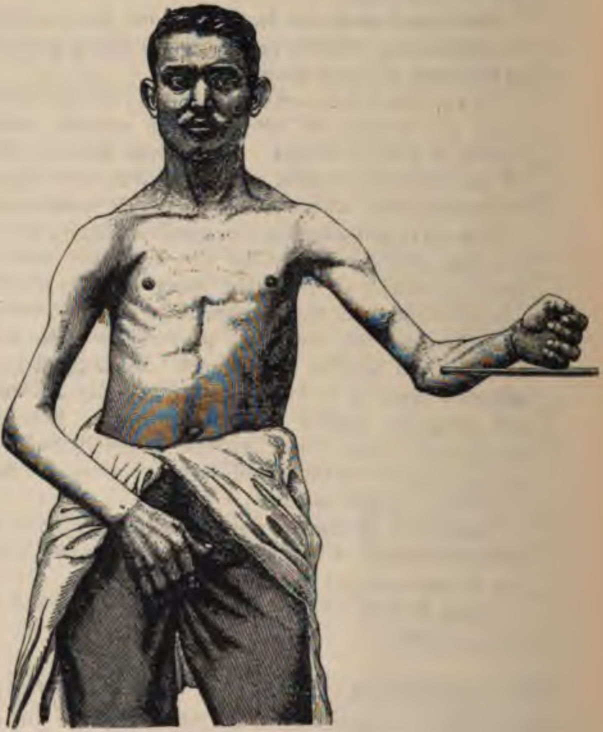

Fig. 1.

More careful examination brings out, as in the case of the last patient, extensive *wasting* and *loss of power* in a large number of the muscles in the trunk and upper extremities.

The details are as follows: pectorals gone on each side, all but the clavicular portion; trapezii all but disappeared; latissimi on the right side almost altogether, on left in great part gone; serrati magni the same; rhomboids atrophied to a slight extent; biceps on right side greatly atrophied and weak, on the left in the lower half as on the right, in the upper half contracting strongly into a hard lump; brachialis anticus on the right side more atrophied than on the left; supinator longus almost quite absent on both sides; triceps greatly atrophied on both sides, more on the left; extensors in the forearm on right side partially gone, also first and second interossei on right side somewhat weak and wasted; erector spinæ a little weak on both sides, especially on the right; lateral abdominal muscles distinctly weak.

In marked contrast to these the following muscles are *normal* or even *enlarged* and *very powerful*: sterno-mastoid distinctly enlarged; levator anguli scapulæ, splenius, muscles of the neck and supraspinatus normal and very powerful; infraspinatus on both sides hypertrophied and very hard; teretes and subscapularis normal; recti abdominis very powerful, distinctly hypertrophied; deltoid on both sides hypertrophied, very powerful; extensors in the forearm on right side only partly preserved, on left very powerful, and for the most part hypertrophied; flexors in the forearm very powerful, and in part distinctly hypertrophied, especially on left side; small muscles of the hand on left side quite, on right for the most part, normal.

Dynamometer marks on the right side 30°, on the left 50°; upper arm is 2 to 3 cm. less in circumference than the forearm.

If you take hold of the patient by the armpits, as if you were going to lift him into the air by the shoulders, the shoulders go up at once to the ears, the patient having no power of fixing them below (absence of the latissimi and pectorals). If the arm raised to the horizontal level is brought down strongly against powerful opposition, the scapula is strongly drawn towards the upper arm and its angle is moved outwards (defective fixation by the trapezius and rhomboids). These are two very characteristic symptoms. The thorax is widened out at the sides with slight eversion of the lower edges (weakness of the lateral abdominal muscles).

In the lower extremities there is only enlargement of the muscles. The glutæi are large, very powerful, and distinctly hypertrophied; the quadriceps, sartorius, tensor fasciæ, and adductors all appear unquestionably hypertrophied, and display great strength; the muscles of the legs are normal, powerful, perhaps hypertrophied (his riding-trousers have become too narrow for him).

The muscles feel in some parts very tough and firm, in others softer and more flaccid. No fibrillar twitchings; mechanical irritability lowered when there is atrophy; where there is hypertrophy, normal or even increased. Electrical irritability behaves in the same way; no reaction of degeneration. Skin reflexes normal; tendon reflexes present in lower extremities, absent in upper. All kinds of sensibility, brain, special senses, internal organs perfectly normal.

But there is something else about this patient, gentlemen. Look at his face. The lips are remarkably thick, while the chin and lower parts of the cheeks appear fallen in, there being distinct wasting of the left half of the chin. If we test the functional activity of the muscles we find the frontals, orbiculares palpebrarum, and zygomatics normal, but distinct weakness of the left side of the mouth and of the left buccinator—brought out in showing the teeth, in whistling, and in puffing out the cheeks. Palpation shows undoubted wasting and softness of the left side of the mouth and chin, It is not easy to say for certain whether things on the right side are normal. The muscles of mastication of the tongue and of the pharynx, the ocular muscles, and the pupils all perfectly normal. The patient did not know that there was anything wrong about his face, and can therefore tell us nothing about when it began.

In this case then, gentlemen, which in other respects agrees in all essential points with the first one (putting aside some interesting details) we have a juvenile muscular atrophy with affection of the face.

Let us take another case.

3. Look at this little Hercules we have here, and observe, particularly, the enormous development of his limbs, especially the legs and glutæal regions, his somewhat stupid expression, and the peculiar attitude.

Philip Arnold, nine years of age. Family apparently quite healthy, except that a younger brother is affected in the same way; the parents and the two older than himself are healthy. The boy could run about at the usual time, but with some difficulty, and he could never jump; in his second year had convulsions. From his fourth and fifth year he is said to have been getting thicker about the calves, and walking has become difficult and the gait tottering. Intelligence very defective, and has made no progress in school. The first thing that strikes one in examining him is the immense development of the boy in flesh and adipose tissue, especially in the lower extremities, which call up lively recollections of statues of the "Infant Hercules." Note, also, a generally distributed mottling of the skin.

More exact investigations reveal, however, under these deceitful external appearances, not only extensive muscular wasting, but everywhere distinct weakness, even in the apparently normal or hypertrophied muscles. I should except the face: there is nothing abnormal in respect either of function or of size in the muscles of expression, the muscles of mastication, of the tongue, and of the throat. On the other hand, in the trunk and in the upper extremities the muscles affected are almost the same as in the two previous cases, only that in this case a larger number of the muscles appear to be hypertrophied while they nevertheless show motor weakness.

You have then, as you see, *atrophy* and *weakness* in the pectorals (all but small portions), the latissimi dorsi, the biceps and brachialis anticus on both sides, the supinatores longi (almost wholly gone), and the abdominal muscles.

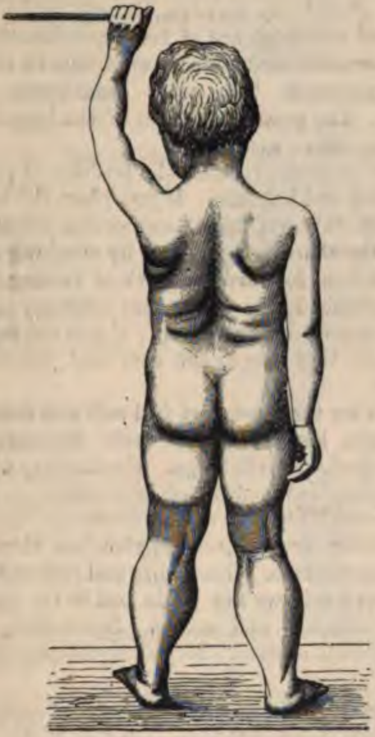

Fig. 2.

On the other hand, you have *enlargement* and *weakness* in the deltoids, rhomboids, infraspinati, serrati magni (forming a large swelling surrounding the scapula in front and below), tricipites, and extensors and flexors in the forearm (which form nodular swellings on active movement).

The extensors of the spine are very weak; down to the level of the first lumbar vertebra they are distinctly atrophied, from the first lumbar to the sacrum they are enlarged, forming a thick soft swelling on either side.

The following muscles are apparently quite *normal*: trapezii. sterno-mastoids, supraspinati, teretes, subscapulares, and small muscles of the hand. The small size, along with the maintenance of their function in these muscles, stand in marked contrast with the enlargement and weakness of most of the others.

The lower extremities, as you see, are very large in their whole extent. The glutæi are massive, though rather soft and weak. The muscles of the thigh are of immense size and of firm elastic consistence, forming hard nodular swellings on contraction; they are pretty powerful. The same description applies to the gastrocnemii. The muscles in front of the legs, though no doubt enlarged, seem rather weak.

The feet are to some extent in the position of pes equinus. The gait is waddling and helpless. If you place the boy sitting on the ground he can only get up by supporting himself against some object, or, in the characteristic way, by climbing up his own legs; if the trunk is bent forward the work of raising it to the upright position is performed only with great difficulty and with the help of the arms supported in some way; if you attempt to lift him up by the shoulders they rise to the ears and you feel as if you had no grip at all.

The muscles for the most part feel soft and flabby; those of his calf and thighs, however, have more firmness and elasticity. There are no fibrillar twitchings. Excitability of the muscles to simple percussion is all over much diminished, so also his galvanic and faradic irritability (in varying degrees); the contractions on direct stimulation are rather sluggish, but there is no definite reaction of degeneration. Sensibility and skin-reflexes everywhere normal. Tendon-reflexes not made out in the upper extremities, in the lower distinct and active. Sphincters, special senses, internal organs, all normal. Mental development very defective.

Gentlemen, you have here a really classical case of the pseudo-hypertrophic paralysis of children, as it is called. The next case presents a somewhat different picture.

4. He is also a boy of nine years of age, Wilhelm Bücher, and comes of a family in the Taunus, in which no trouble like his has been previously known. He learned to run about at the usual time, but he was slow in his movements, and "he couldn't jump" or take part in the usual boys' games. During the last two years he has been tumbling more frequently, has been unable to get upstairs, and his attitude and mode of progression have bit

by bit become what you will see presently. For the rest, he is in good health, is well on in his education, and has never had either pains or convulsions.

The boy is now undressed, and you will see first that the skin is very mottled, next that he stands in a very peculiar way; there is extreme lumbar lordosis, the abdomen is very prominent, the shoulders are drawn well back, the arms hanging down far behind, and the feet are planted a good way apart, giving a broad base of support. There is not much fat on him; the upper part of the body is relatively spare, the upper arms especially are surprisingly thin, and the shoulder-blades stand out; on the other hand, the legs and buttocks are relatively large, while the thighs are relatively small. He walks in a peculiar waddling, high-stepping, straddling fashion, with an approach to the talipes equinus position of the feet; if you set him down he doesn't go

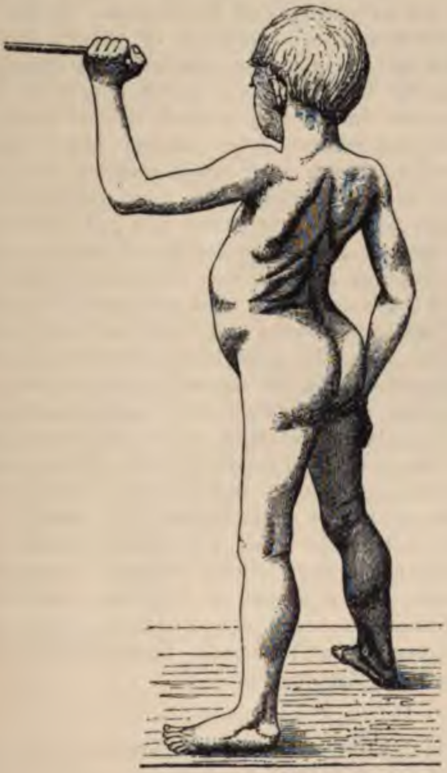

Fig. 3.

down gradually, but suddenly and all of a heap; if you take him under the armpits and attempt to lift him you find yourself getting no hold over his body but merely raising his shoulders to his ears; if he wishes to raise himself from a squatting position he first gets on all fours and then clambers with his arms up his own legs, bringing himself with a jerk at the last into his ordinary position of lumbar lordosis.

On closer inspection we recognise here also the presence both of atrophy and hypertrophy of the muscles. In the upper half of the body there are in a condition of *atrophy* and *paresis*—the pectorals (all but the clavicular portion), the trapezii (in the lower two-thirds), the latissimi dorsi (quite gone), the bicipites and brachiales antici (moderately wasted), the tricipites (to a slight degree), the supinatores longi (almost quite gone), and the extensors of the trunk (very much wasted); in a condition of *hypertrophy*—the infraspinati (in good condition functionally also), deltoids (vigorous but rather soft and wasted posteriorly); in *normal* condition—sterno-mastoids, rhomboids, serrati magni, levatores scapulæ, supraspinati, coracobrachiales, flexors and extensors of the forearm, and small muscles of the hands. In the lower half we have *atrophy* and *weakness* in the following: the flexors of the hips, the quadriceps, and the lateral abdominal muscles; *hypertrophy* in the tensor fasciæ, sartorius, perhaps the adductors, the peronei (distinctly weak), gastrocnemii (very strong). The glutæi and recti abdominis appear *normal*. The muscles of the face and of mastication are quite normal.

The muscular substance is in part soft, in part firm and elastic. No fibrillar twitchings. Mechanical and electrical irritability lowered in the atrophied muscles, no trace of reaction of degeneration, sensibility and skin reflexes normal. Tendon reflex absent in the triceps, almost absent at the knee, active in the tendo Achillis. Sphincters, organs of special sense, mental condition and internal organs perfectly normal. Lower section of the thorax much dilated and flattened out.

According to former usage, gentlemen, this case also would have been termed pseudo-hypertrophic paralysis without more ado, although, as you have satisfied yourselves, the muscles that are enlarged and are acting well by no means give the impression of pseudo-hypertrophy or lipomatosis. We cannot properly call it an example of Leyden's hereditary atrophy, because, though in other respects akin, it lacks the quality of heredity, on which so much stress has been laid by Leyden. It would agree better even with the features of the variety I have termed juvenile atrophy, had it not taken origin in very early childhood.

That, however, need not give us any great concern in the meantime.

I should next like to bring before you for a moment two of the same family, in whom you can discern the earliest stages of the disease.

5 and 6. These two cases are sisters. The parents are free from the affection, and no similar case has occurred so far as they (the parents) are aware in the families of either of them. Our little patients, however, have a stepbrother (son of the same father by a sister of their mother's) whom I saw in 1875 in the first stages of the trouble, and who now has advanced atrophy over the whole body, with contracture in several places. In him the face is unaffected.

I saw the girls two years ago, and will tell you what I found then, that you may compare the record with their condition to-day. The elder of the two, Helene, is now fourteen years of age. In April, 1888, the affection had been gradually coming upon her for several years, with weakness of the legs and back, and latterly some difficulty in mounting stairs. The examination at that date gave the following results: face quite unaffected; atrophy of the latissimi, trapezii (lower two-thirds), and rhomboids; less marked but still distinct wasting of the pectorals, flexors in the upper arm, and supinators; hypertrophy of the infraspinati and serrati; weakness and wasting of the lumbar muscles; distinct atrophy of the thigh, especially of the quadriceps, knotty condition of the latter in contraction; sartorius normal; moderate enlargement of the calves; muscles generally firm; slight affection of the gait and characteristic climbing up the legs in rising from the ground; quite healthy otherwise.

Now, as you observe, the affection has advanced a bit. The atrophy of the muscles I have named is distinctly greater; the latissimi, the flexors of the forearm, and the supinators, have in particular distinctly grown weaker; the lower half of the pectorals is almost gone; the weakness in the thighs is increased. In addition to the infraspinati the deltoids and tricipites are now manifestly hypertrophied, and the calves are distinctly larger. There is some weakness in the peroneal region; the walk is high-stepping (*steigend*). Face remains quite normal. No fibrillar twitchings, no reaction of degeneration, knee jerk weak, and tendo Achillis reflex active.

The younger sister, Auguste, is now ten years old. She was only brought to me in April, 1888, by her anxious mother because, as she said, "she cannot run upstairs like other children." The mother did not at that time think of her otherwise than as quite healthy. The only things I could then be certain of were that the latissimi were distinctly atrophied, the trapezii rather weak, the biceps on either side somewhat thin, and, on the other hand, the serratus magnus on either side very strongly developed. The face was quite intact, and there was no pseudo-hypertrophy anywhere.

To-day you can see that the disease in this poor child has made a distinct advance. The lower portions of the pectorals are markedly atrophied, also the supinators and flexors of the fore-arms. The angle of the scapula stands out somewhat (weakness of the latissimus and trapezius); the child's shoulders are loose; if the arm held horizontally is brought down strongly against an endeavour to keep it up, the angle of the scapula moves outwards. Triceps and infraspinatus on each side distinctly hypertrophied. Weakness of the extensors in the loins, and slight lordosis of the lumbar vertebræ. Quadriceps weak and nodular on contraction. Rising from the squatting position impossible without assistance. Calves greatly enlarged. Face absolutely intact, no fibrillar twitchings, tendon reflexes active.

What are we to call these two cases? Assuredly not pseudo-hypertrophic paralysis, or disputes would arise. Perhaps we might reckon them cases of hereditary muscular atrophy, for we have the heredity and the commencement in the legs and sacral region. And yet the early affection of the shoulder girdle and upper arm brings them nearer to my juvenile form. Here, also, this question may remain undecided at present.

Unfortunately I cannot show you a case in which the disease has begun, and is specially marked in the face. I have not, up to the present, met with such. They appear, in Germany at any rate, to be very rare. Strümpell has lately described and given illustrations of a case in his "Spec. Pathologie" (vol. 2, 1, 5th edit.) In France Duchenne[3], and of late years Landouzy and Dejerine[11] and Marie and Guinon[13] have recorded a number of such cases, calling the form "infantile" muscular atrophy.

You have now, gentlemen, a fairly complete idea of the variety of forms which this disease assumes. It will not have escaped your notice in what respects these various forms agree (and in some ways the agreement goes very far), and in what respects they, to a certain extent, differ.

They all agree in the slow and insidious development of the disease, with very frequently hereditary or family influences at work; in the general wasting of many of the muscles, combined with increase in the size of others; very notably in the localisation of the affection, in that almost invariably they are exactly the same muscles in the different cases that atrophy on the one hand, and exactly the same that become hypertrophied in the other; in the way in which this localising takes place in the trunk, shoulder girdle, and loins, and in the proximal ends of the limbs, the distal ends remaining free for a long time; and in the peculiar changes which are then brought about in the form and movements of the body, the attitude, and gait. They agree further in the condition of the muscles, as ascertained by percussion and palpation, in the effects of electrical stimulation, particularly in the absence of the reaction of degeneration, in the fact that there are no fibrillar twitchings, and in the gradual disappearance of tendon reflexes. Finally, in all of them the various forms of sensibility, the sphincters, the brain and organs of special sense, and all the internal organs, are quite normal.

Thus in all the forms the outline of the features is the same, and yet there are certain differences which cannot be overlooked. These are as follows: Some of the cases appear to be independent of hereditary influences; sometimes the process begins in earliest childhood, sometimes in youth or at puberty, sometimes even later. In some cases it makes its appearance first in the loins and lower extremities; in others in the shoulders and upper extremities; at times even in the face. The rules of localisation are often set aside, the muscles of the forearm and small muscles of the hand being sometimes attacked, and muscles which, as a rule, are affected, being sometimes exempt. The degree of muscular hypertrophy may vary extremely, at times being quite unnoticeable, or limited to a few muscles, at times extended over a wide area, and present in a very marked degree. Further, this hypertrophy appears in some of the cases to be a true hypertrophy, depending on actual increase in volume of the muscle substance, and in others to be false, caused by a deposit of fat or lipomatosis. Lastly, the rate at which the disease advances, and the way in which, towards the close, all the muscles of the body may be affected, are very different in the individual cases.

Are those differences sufficiently great and sufficiently essential to justify us in ranging the cases under different nosological forms? You know that already we have quite a number of them. Pseudo-hypertrophic paralysis has long had a position of its own, and the enlargement of the lower extremities, the fatty deposit on the muscles, and the peculiar attitude and gait might seem distinctive enough. Then Leyden[8] brought forward his hereditary muscular atrophy, and gave as its pathognomonic characters heredity and commencement in the back and lower extremities. I followed[10] with juvenile muscular atrophy, distinguished by its beginning in the upper half of the body, a peculiar localisation, the presence of muscular hypertrophy, and the absence both of fibrillar twitchings and the reaction of degeneration. Lastly, we have had lately a form that Duchenne had described as infantile muscular atrophy, but now brought forward by Landouzy and Dejerine[11] under the name "myopathie atrophique progressive," as an independent and, indeed, as the most important form of the disease. Nor would it be difficult to specialise still further, and extend this list, as you can see from a perusal of Raymond's recent exhaustive work.[14]

The longer I have occupied myself with the question, and the wider my experience of these forms has grown, the more has the conviction forced itself upon me that they all present one and the same disease. I am satisfied that, while in subordinate features such as the time and rate of development, the initial localisation, quantitative differences in the individual symptoms, particularly as regards the amount of hypertrophy, they may differ from one another, yet in all essential points they thoroughly agree.. The proof of this clinical unity of those forms must, in the first instance, of course, be deduced from clinical material, but, from the number of my own cases and from a record on the part of others which has gradually grown to be very large, we have no difficulty about that.

First of all we must establish the fact that the separate forms agree with one another in the following particulars: The development and the localisation of both the atrophy and the hypertrophy in the muscles; the condition of the latter, as ascertained by inspection and palpation, by their mechanical and by their electrical reaction; and, lastly, the absence of all other symptoms. Now, that they do agree in these respects you have already seen, even from the few cases I have shown you. A more extended series of observations would bring it out with still greater certainty, and would easily show that the juvenile, the pseudo-hypertrophic, the hereditary, and the infantile forms agree in all the above-mentioned particulars to an extent that is quite surprising. You must allow me on the present occasion to forego the details of this proof, as it would take up too much of our time.

But still more convincing evidence is given by the cases, and they are not so very rare, which may be looked upon as transitional varieties between those individual types—cases of one form in which you meet with certain features which you have learned to consider as properly belonging only to another form. For example, there have been lately observed several cases, both of the juvenile and of the pseudo-hypertrophic form, in which the muscles of the face have become involved (as in the second case which I showed you); or you may see the infantile form, beginning with pronounced facial atrophy, developing, as regards the rest of the body, at one time the juvenile type, at another time the pseudo-hypertrophic type; or you may observe the lower half of the body take on the distinct pseudo-hypertrophic type, while the upper half is an example of simple atrophy—the juvenile type; or you may have the exact appearances of pseudo-hypertrophic paralysis, coming on in adult life, *i.e.*, as a juvenile form.

Further, we not infrequently see the different forms passing into one another in the course of their development. A case that began as pseudo-hypertrophy takes afterwards the juvenile or infantile form; a hereditary case turns into a pseudo-hypertrophic or juvenile case, and so on. We frequently come across cases, also, which I should like to call indeterminate or, better, indeterminable forms, cases in which there may be doubt as to which type they belong to. We have seen an example of this in our fourth case, and to a certain extent in the two sisters (cases 5 and 6). In a case of this kind one man sees one type, another, another; or perhaps the case has been taken for a certain type at one time and two years later the physician finds himself inclined or obliged to call it an example of another. And yet all these cases most certainly belong to the same nosological group.

Different types occur in the same family, and this fact, it appears to me, speaks with great force for the view we are upholding. For in that case they occur in circumstances where there is no room for doubt as to the unity of the disease. For example, the infantile form may appear among children whose father has the juvenile form (observed by Duchenne, Landouzy-Dejerine, Troisier-Guinon [15] and others), or different types may occur in a family in which the hereditary form has already gained a footing. These are, I think, very convincing proofs.

I believe that the facts I have laid before you in the present state of our knowledge, and disregarding just now the proof from pathological anatomy, to which I shall return later, are sufficient to allow you to recognise in all the different types one nosological species. It is fitting that we should have for this a short distinctive name, and I proposed as such *Dystrophia muscularis progressiva*. I still think that it is the best, and that it involves fewer assumptions than any of those that have been proposed by others.*

Let us now sketch the clinical features of the disease as we learn them from a study of a sufficient number of cases of the various types. The picture thus formed will be a standard to go by in the differential diagnosis between progressive muscular dystrophy and other similar affections.

It always begins very slowly and insidiously, and in many cases remains unnoticed for a long time, perhaps for years. It begins sometimes at one age, sometimes at another, but most commonly there is a preference (probably due to the influence of heredity) for childhood and infancy, though commencement about the time of puberty is not infrequent. Much more rarely it develops in later years and towards the fifties.

It begins generally in the trunk and proximal parts of the extremities; sometimes the lower half of the body, including the pelvic girdle and thighs, is the first and most severely affected, sometimes the upper half with the shoulder girdle and upper arms. The earliest symptoms are weakness and exhaustion in the affected parts, with awkwardness in using them. Pain, paræsthesiæ, and other symptoms are absent. In a certain number of the cases in children the lesion appears to commence in the face. In this position it may remain unnoticed for a particularly long time, and it is only when it has gone very far, has given to the patient a peculiar expression, and gravely affected the facial movements, that it attracts attention. As the disease progresses, the growing weakness and defect in the movements of the muscles always become associated with distinct changes in their volume. These changes are of two kinds: we may have atrophy, and this is generally manifested in certain particular muscles, or we may have hypertrophy, most prominent in certain other particular muscles; the latter may be true hypertrophy or, especially in the later stages, false or fatty hypertrophy. It is not improbable that in the case of most of the muscles there is a hypertrophic stage, which very seldom comes under observation, as the patients in general only seek medical aid when there is already atrophy. This is the impression, at any rate, made by the study of the morbid changes in some of the muscles. The dividing lines between hypertrophy and atrophy in individual cases certainly shift about in the most varied fashion, and the following list of the muscles which are most commonly atrophied and of those which are most commonly hypertrophied is only to be taken in a very general way, and as admitting of many exceptions.

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* The name chosen by Fr. Schultze,[12] "Progressive muscular wasting associated with hypertrophy," is too cumbrous, and scarcely suitable for others than Germans. The "Myopathie atrophique progressive" of Landouzy and Dejerine takes no account of the hypertrophy that is generally present. Charcot's[16] "Myopathie progessive primitive" would suit best of all if it were only certain that the myopathy is primary.

In moderately advanced cases the following muscles are found for the most part more or less atrophied: The pectoralis major and minor (except, generally, the clavicular portion), trapezius, latissimus dorsi, serratus magnus, rhomboids, sacro-lumbalis and longissimus dorsi. Further, and this is very characteristic, the flexors in the upper arm (biceps and brachialis anticus), including the supinator longus. In addition to these, there may also be affected the lateral abdominal muscles, the glutæi and quadriceps femoris, frequently, also, the adductors; in the leg the peroneal muscles, and particularly the tibialis anticus. In all these muscles, along with the atrophy, there is growingly distinct motor weakness. If the face is involved it is especially the muscles around the mouth and chin which atrophy, frequently also the orbiculares palpebrarum and frontales.

The following muscles are generally, though, as I have said, often only for a time, hypertrophied: the deltoid, infraspinatus (more rarely also the supraspinatus) and triceps in the upper half of the body, the tensor fasciæ, sartorius and gastrocnemius, possibly the whole calf in the lower half. In these muscles the motor power may be very good, sometimes almost abnormally so, but you often find them getting pretty weak, even in an early stage.

Lastly, the following are normal, and, in general, long remain so: The sterno-mastoid, levator anguli scapulæ, coracobrachialis, teretes, flexors and extensors in the forearm, and the small muscles in the hand; the rectus abdominis, and in part the muscles of the leg, especially of the calf, and the small muscles of the foot.

Of course here, also, the boundary line between what is affected and what is not often cannot be fixed with anything like precision. Sooner or later, muscles that were previously intact are involved. First, as a rule, come the extensors in the forearm, then the small muscles in the hand and flexors in the forearm, and, finally, the morbid process may extend over the whole body, sparing not even the diaphragm or the muscles of respiration. Extremely rarely it may happen that the muscles of mastication and the ocular muscles are attacked. The patients finally become wasted and helpless all over, or, with equal helplessness, the atrophy may be masked by masses of fatty tissue, giving an appearance of muscular volume. In no case does the disease go on to bulbar paralysis.

In moderately advanced cases the peculiarities in the form, attitude, and movements of the body affected by the muscular lesion are extremely characteristic. There is marked lumbar lordosis, the upper half of the body arching well back and the abdomen being protruded in front; the shoulders are lowered and brought forward; the line running from the side of the neck to the apex of the shoulder is divided into two by the prominent superior angle of the scapula; the shoulder blades may stand out like wings, and often possess a very comical mobility, from not being fixed down in the usual way by the trapezii, latissimi, rhomboids, and serrati, while the fair development of the infraspinati may give them at the same time a singular appearance of deformity. If the arm is raised to the horizontal level and brought down again against some resisting force, the inferior angle of the scapula is turned very much outwards and is approximated to the arm by the powerful action of the teretes and infraspinatus. This is due to the absence of the usual fixation by the rhomboids and trapezius. The thinness of the upper arm is very striking, from the large size of the deltoid above and the powerful forearm below. The latter has more of a cylindrical form than usual in its upper portion from the absence of the supinator longus. The infraclavicular fossa is hollowed out and there is an oblique groove alongside the insertion of the deltoid, from the absence of the pectorals. The wasted condition of the thigh is brought out by contrast with the well-developed buttock and the huge calf. The walk is peculiarly waddling and high stepping, with pointing of the toes; mounting stairs is difficult. The way in which the patient sits down on the ground and rises up again is highly characteristic; in the latter movement he gets on all fours, with the legs extended, and then, with his hands, climbs up his own legs, attaining the upright position at the last with a jerk. The weakness of the quadriceps, erector spinæ, and glutæi is responsible for this. The shoulders are very slack, and if the patient is lifted up by the armpits, the shoulders rise at once to the ears (weakness of the latissimi, pectorals and trapezii). Not uncommonly, especially in children, we notice an anomalous condition of the lower part of the thorax. It is flat and retracted in the middle from the action of the powerful rectus abdominis and prominent at the sides, the edges looking almost as if turned up. The latter appearance is due to the weakness of the oblique and transverse abdominal muscles; at the attempt to raise the head in the lying position these muscles appear as two soft tumours in the lateral aspect of the abdomen.

If the face is affected early and in a high degree, a characteristic facial expression is produced ("facies myopathique" of the French). The countenance is like a mask, smooth and immovable, the lips thick and prominent, "tapir lips," the patient is unable to whistle, to close the lips firmly, or to wrinkle the eyebrows; the play of features is poor, and there is a very peculiar alteration in the smile (*grünes Lachen, rire en travers*).

This picture, it is well-known, can be modified in a great variety of ways. The distribution and intensity of the process, the difference in the way it affects the upper and lower half of the body, the absence or presence of hypertrophy, the stage at which the disease has arrived, the individuality of the patient, and the family type, all help to produce these modifications. To go into a description of the possible varieties on this occasion is quite superfluous.

But there is still something more to ascertain to complete the necessary precision and objectivity of the description. The atrophied and hypertrophied muscles on palpation show changes in their consistence which are often very marked. Sometimes they are soft and flaccid, with the feeling of a fatty growth, at other times elastic and firm. On active contraction they may form irregular nodular tumours, and easily pass into a condition of tonic spasm or cramp, The mechanical irritability is mostly lowered, often in a very marked degree. The faradic and galvanic irritability is always lowered in the atrophied muscles and frequently in the muscles which are enlarged; but if there is true hypertrophy the electrical irritability may remain normal. There is no reaction of degeneration.* You will further find that fibrillar contractions are as good as never present.† That is, not reckoning as such the muscular tremors and twitchings which are so frequently seen in those exposed to cold or in a state of excitement. These may occur in anyone, well or ill, but are especially observed in "nervous" people.

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* I must stand by this statement, in spite of the fact that in my first paper I spoke of the absence of the reaction of degeneration as by no means absolutely certain, and although in one case (described by Fr. Schultze) at an advanced stage, I ascertained for myself that this reaction was quite distinctly present in various muscles. Several observers have, indeed, asserted its occurrence; but even if I grant that what they saw was actually the reaction, and not something like it, some slowness of contraction. or such like peculiarity erroneously taken for it—my own experience has taught me that an error like this is quite possible—nevertheless, from numerous careful observations I can only repeat that the absence of degeneration in the dystrophic affection is almost without exception the rule. I shall have more to say of this afterwards.

† In regard to this statement, also, I have been criticised a good deal, and accused of being in error. If in one case, for example, a muscle (the masseter) that was not even for certain affected at all, showed fibrillar twitchings, while in the rest of the body in which the disease had reached an advanced stage nothing of the sort was seen, even with long observation, it has been thought quite justifiable to say that the statement above is unwarranted. The same criticism is made when, in another case, fibrillar twitchings had been noticed (so it is said) on the first day, but never again in the course of several weeks' observation. Such remarks correct themselves, the exception simply proving the rule. In spinal muscular atrophy and amyotrophic lateral sclerosis, fibrillar twitching is always present and widely distributed, but from a large experience of progressive muscular dystrophy, I must hold to my assertion that the absence of such twitching is in this disease the almost invariable rule. Even if here and there it is observed, we must remember that its occasional or even constant occurrence in neurasthenic, and, indeed, in healthy people, is not so very uncommon.

The tendon-reflexes are diminished in all the muscular areas where the disease has gained a firm footing, and finally they disappear altogether; the skin-reflexes generally persist for a longer time. In many cases, and often in an early stage, contracture occurs, or rather retraction of certain muscles, and this may lead to abnormal positions of the limbs; the commonest are pes equinus and contracture in flexion at the knee and elbow. It only remains to mention the peculiar mottling of the skin, which is so especially marked in many children with pseudo-hypertrophic paralysis. Everything else—sensory and trophic functions of the skin, sphincters, sexual power, special senses, brain, all other internal organs, and all vegetative functions—are normal.

Turn now to the differential diagnosis. We require first of all to distinguish it from spinal muscular atrophy, amyotrophia spinalis progressiva, the pathological basis of which is believed to be a disseminated degeneration of the anterior columns of grey matter in the cord. This disease, also a form of slow muscular wasting, is characterised by the following features: There is rarely evidence of heredity, and it begins generally in adult years; the small muscles of the hand are almost always the first to be attacked, with gradual atrophy of the individual muscles, extending progressively to the forearm, upper arm and trunk, affecting the lower extremities only at a later period; there is never either true or false hypertrophy of the muscles; fibrillar twitching in abundance is generally present; electrical irritability is long preserved, but at the last in the most of the muscles, when the atrophy is advanced, there is always the reaction of degeneration, either partial or complete, and occurring with most regularity in the small muscles of the hand; tendon reflexes generally long maintained, very often combined with chronic bulbar paralysis. Everything else—sensory functions, special senses, sphincters, &c.,—normal. In this list I have given you the determining elements for the differential diagnosis. The most important are the different localities affected, the progress of the disease from the distal ends of the limbs to the trunk, the absence of hypertrophy, the presence of fibrillar twitching and of the reaction of degeneration, and the association with bulbar paralysis. As a rule the distinction is easy. In difficult or doubtful cases when, for example, the spinal form begins in the trunk or shoulders, or the dystrophic form attacks the small muscles of the hand at an early stage, careful examination of the other symptoms and the further progress of the disease will generally guide to a right conclusion.

The distinction from syringomyelia, a disease of which many cases were formerly put down to progressive atrophy, is very simple. The localisation of the affection is of the spinal type, there is atrophic paralysis with the reaction of degeneration, hypertrophy is absent, and, above all, there are sensory disturbances—pain, paræsthesiæ, anæsthesiæ, in particular partial sensory paralysis for pain and temperature.

So, also, is the distinction from chronic multiple neuritis, which frequently presents a certain similarity to progressive muscular atrophy. But the pain and sensory disturbances, paralysis and atrophy, with the reaction of degeneration, the absence of hypertrophy, and the localisation, all these are sufficiently characteristic to guard against any confusion. The same holds good for another form of progressive muscular atrophy which has lately received close attention. Eichhorst [17], F. Schultze [18], Charcot and Marie [19], Herringham [20] and others have described cases, and J. Hoffman [21] has recently given a careful study of them under the name "progressive neurotic atrophy" (type Charcot-Marie or "peroneal" type of the English). The place of this affection in a systemic arrangement is not yet quite clear. Its features, however, are atrophic paralysis, especially in the feet and legs, later on in the hands and forearms, with deformities, reaction of degeneration, fibrillar and fascicular twitching, frequently, also, with sensory disturbances, &c. Thus, although the disease has a distinctly hereditary character, and begins for the most part in early childhood, it is very easily distinguished from our dystrophy.

Diagnostic difficulties may, perhaps, arise in rare cases, such as out of the way localisations of focal disease in the cervical or lumbar cord, or peculiar combined peripheral paralyses (plexus-paralyses). For example, I have seen a bilateral birth paralysis affecting the shoulder and arm which at first closely imitated the features of progressive muscular dystrophy, and another similar case in which the deformity was caused by bilateral operations in the supraclavicular fossæ. Certain surgical affections, for example, bilateral dislocation of the hip joint, flail joints, &c., may, on account of the secondary muscular lesions, imitate the disease, but as a rule a careful history and examination will clear up such cases.

And now, gentlemen, that we have got so far, let us see what we can learn from pathological anatomy, and inquire whether this is favourable or not to our view of the clinical unity of the various forms of dystrophy. In this region we are no doubt still moving on uncertain ground and amid much discussion, but gradually matters are clearing up, and that, as far as I can see, favourably for our views. I shall, however, be as brief as possible in what I have to say.

I have myself examined excised pieces of muscle from a whole series of cases of the most varied types. Other observers have done the same, and quite recently several autopsies have been made in juvenile, infantile, and pseudo-hypertrophic forms; we have at our command, therefore, a fair quantity of material.

Taking first of all the changes in the muscles themselves, I may begin by saying that the results of the examination of muscle obtained *post-mortem* thoroughly agree with the results of the examination of portions excised during life. Further, so far as I can at present judge, the condition of the muscles in all the various forms of dystrophy is in all essential points almost precisely alike; apparent differences are brought about only through quantitative distinctions in the various histological changes, and through varying combinations of these changes at different stages of the disease in different muscles and in different individuals. The differences between individual muscles in the same patient are not less than those between muscles from different forms of dystrophy, and it is thus quite legitimate to represent all these forms as varieties of one disease. On the present occasion, however, we are not going beyond a brief outline of the features of the disease.

Formerly the greatest stress was laid on the changes in the interstitial connective tissue. These were looked upon as the primary lesion, and the essence of the disease was conceived to be the overgrowth of the interstitial tissue, and especially the formation of fat. The affection of the muscular fibres, according to this view, was secondary. They had atrophied, been, so to speak, surrounded and suffocated through the overgrowth of the connective and fatty tissue. But our investigations have led us to quite other views. We find that the most important and most essential changes are in the muscle fibres themselves, and look upon the alterations in the connective tissue rather as accompanying accessories, perhaps as secondary.

These muscle changes are the following: First of all there is very considerable hypertrophy of the fibres, to as much as three or four times the normal.* Then there are all possible degrees of atrophy; rounding of the fibres till they are circular in form; increase of the nuclei both at the edge and in the interior; the formation of slits and the division of the fibres into two or more finger-like processes; vacuolation, sometimes only here and there, sometimes to a greater extent; faint transverse and pronounced longitudinal striation, with a tendency to splitting of the fibres into longitudinal fibrils. On the other hand, there is no fatty or wax-like degeneration of the fibres.

The changes in the connective tissue are increase and overgrowth, slight to begin with, more abundant later on. There are firm broad strands lying between the muscle-fibres, with abundant nuclei and thickened multinucleated vessel-walls. Besides these changes there is sooner or later more or less of a deposit of fat, which may go on to distinct lipomatosis.

These alterations show themselves in very different degree in the different muscles, and may be combined in the most varied way. Between muscles which give the impression of being quite normal and possess only hypertrophied or normal fibres, with a small quantity of connective tissue, and muscles which are instances of pure fibrous or fatty degeneration, in which there are only the scattered remnants of hypertrophied or atrophied muscle-fibres, there is every conceivable stage, combination, and transition. Not uncommonly in one individual, nay, in different parts of one and the same muscle, every stage and degree of the morbid process can be studied. I show you here a drawing, itself diagrammatic certainly, but copied from different actual preparations, and true in its details, which will bring before you these different stages and forms (see fig. 4).

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* I know very well that, according to the observations of Auerbach and of Oppenheim and Siemerling[23], the existence of this hypertrophy *intra vitam*, at least in the fragments of muscle excised from the living subject, has been called in question. But as it is present in exactly the same way in muscles taken from the dead body, and as we can decidedly infer from the marked proliferation of nuclei and division of the fibres that there is some process of overgrowth going on in the muscle, I should like in the meantime to hold by the real existence of this hypertrophy, though its exact degree may possibly be modified and conditioned by the method of preparation. Knoll's work[24] has thrown some direct light on this point, and leads to the same conclusion.

If you study now the state of the different muscles, and attend to the degree of morbid change and the duration of the disease in each, which can be brought out by looking at the condition of the tissue elements in the various preparations, you will recognise that the most important and the earliest changes are those in the muscle-fibres. The alteration in the connective tissue may at the utmost begin in a small measure at the same time, but more probably follows the changes in the muscle. The lipomatosis, last of all, makes its appearance in the overgrown connective tissue.

According to our present knowledge the cause of the morbid changes in the muscles is somewhat as follows: First, there are alterations in the muscular substance itself. These hypertrophy and their nuclei proliferate; they swell up, taking more of a rounded form, and slitting and subdivision goes on; *pari passu* there is slight increase and proliferation of nuclei in the connective tissue. At an early period, however, muscle-fibres here and there atrophy, and this process quickly extends more or less, gradually gaining the upper hand, and finally leading to complete disappearance of the muscle-substance. Along with it goes on a very great increase in the amount of the connective tissue, with proliferation of the nuclei, thickening of the vessels, and so forth. In this tissue, sooner or later, fat cells make their appearance, leading, it may be, to the most extreme forms of fatty degeneration. The muscular fibre has now wholly, or about wholly, disappeared, and the final result of the whole process is one of two forms. It may be an atrophic and sclerosing lipomatosis, in which there is a good deal of pure connective tissue without much fat, and the original volume is very much reduced, or it may be a hypertrophic lipomatosis

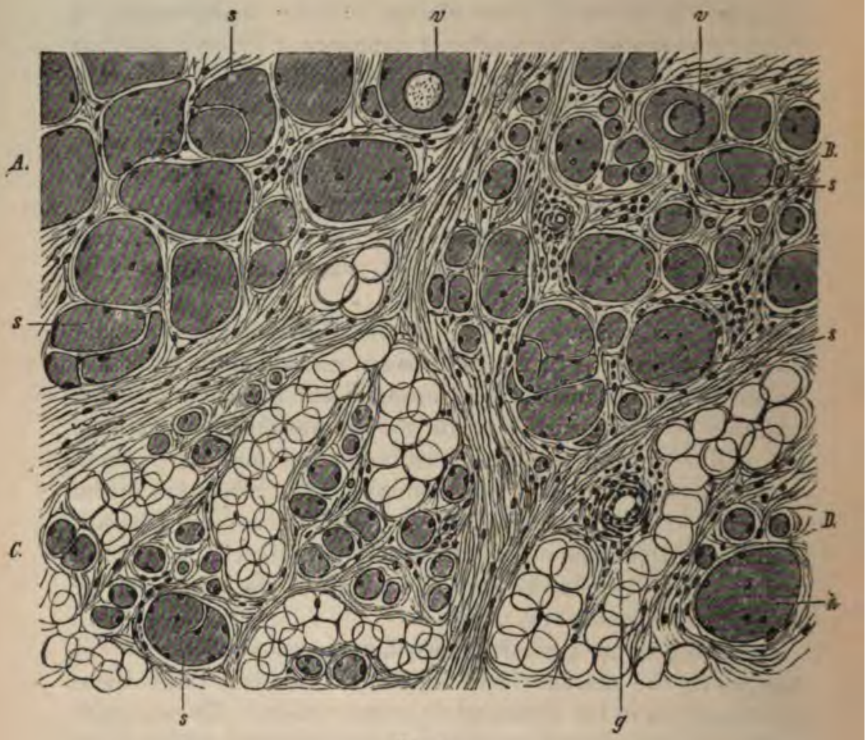

Fig. 4.

Made by combining four different sections from as many different cases.

A. From the hypertrophied deltoid of a typical juvenile case; showing almost everywhere very much enlarged fibres with increase in the nuclei, slitting (*s*), and vacuolation (*v*); slight increase in connective tissue with abundant nuclei.

B. From the atrophied biceps of an indeterminate case (juvenile ? pseudo-hypertrophic ?) showing muscle-fibres of very different sizes, with great proliferation of the nuclei, abundant slitting (*s*), and here and there vacuolation (*v*); connective tissue very much overgrown and with numerous nuclei; no fat deposit.

C. From the enlarged serratus magnus of a pseudo-hypertrophic case (our third case). Muscle-fibres mostly atrophied, here and there enlarged and slit (*s*); abundant firm connective tissue; large deposits of fat cells.

D. From the very atrophied biceps of a juvenile case, showing little else than adipose tissue lying among stout bands of connective tissue, the vessels of the latter very much thickened (*g*); small insulated patches of muscle-fibre in some places still very much enlarged (*h*) with numerous nuclei.

in which there is little else than fat, while the original volume is either maintained or exceeded.

On the other hand, the results of the examination of the nervous system have, up to the present, been almost wholly negative. Leaving out of account Lichtheim's case and the older cases of pseudo-hypertrophy, we have had recently a series of exact records from Fr. Schultze, Landouzy, Dejerine, P. Marie, Dreschfeld, Westphal, and Singer, and neither in the spinal cord nor in the peripheral nerves have any noticeable changes been observed. In accordance with these records, we should be entitled to view this dystrophy as a disease limited to the muscle-substance, and as a truly primary myopathy, were it not that some facts have come out which warn us to exercise great caution in this direction. Heubner's case [22] deserves special mention. Though an undoubted case of dystrophy, he found there was extensive atrophy of the large cells in the anterior horns of grey matter. Frohmaier [30] has a similar case with the changes in it less marked. In this new light the more trifling alterations observed by Singer and the older observations in pseudo-hypertrophic cases of L. Clarke, Gowers, Kesteven, Bramwell, and J. Ross, gain a certain significance. But in the meantime we must say this, that in progressive muscular dystrophy in its various forms, the nervous system must be considered to be, as a rule, and for our present methods of investigation, normal.

This is the place in which to say a little about the proper nature, pathogenesis, and exact seat of the lesion. It is not necessary to prove further that it is neither a simple atrophy of the muscles nor an inflammatory affection with its consequences; there is unquestionably a more complicated disturbance of nutrition, regarding the nature of which, for the present, I would rather not express a definite opinion.

Pathological anatomy has led many to consider it simply as a local muscular affection, quite independent of the central nervous system, a pure myopathy. But a good deal of doubt has been expressed (for example, by Knoll [24]) regarding this view, and I myself, in my earlier work, brought forward some reasons which prevented me from accepting it without more inquiry. A much larger experience, a good deal of consideration given to the subject, and most of all the results of the previously mentioned autopsies have confirmed me in my scruples.

The considerations which weigh with me are various. The muscles depend for their nutrition to a very large extent on trophic nerve centres; the localisation of this atrophy frequently follows in a noticeable way the exact course of the nerves in a plexus, or the disposition of the centres in the central organ, and occasionally we find a case of spinal amyotrophy (Strümpell's case[25]) presenting an almost exactly similar arrangement. Hereditary influence is of great importance; mental aberrations are common among the patients, and other neuroses frequently occur in their families. Further, even in the undoubtedly spinal cases, such as acute anterior poliomyelitis, similar morbid changes (hypertrophy, proliferation of nuclei, division of the fibres) both in the muscles and connective tissue have been pointed out by W. Müller[26], Dejerine-Huet[27], Joffroy-Achard[28], and Hitzig[29]. In pseudo-hypertrophic cases malformations and changes of a minor kind in the spinal cord have been met with. When I consider these facts, and bear in mind further the results of Heubner's[22] and Frohmaier's[30] observations, I cannot avoid the suspicion that after all the affection may be dependent on the nervous system. It is tempting to suppose, as I formerly expressed it, that we have to do with a kind of trophoneurosis, having its origin in the trophic centres of the cord—a disturbance of the function of these centres which finds its expression in the very complicated muscle changes of the disease. While on this supposition there are, as a rule, no coarse nerve changes, now and then, and after the affection has lasted a long time or been very intense, such a change does become visible.

The idea is inevitable that if something like this is the case the relations between dystrophy and spinal amyotrophy will turn out again in the end to be close and intimate. The latter would represent an affection of the trophic centres that from the very first is a distinct coarse anatomical lesion taking effect in a degenerative atrophy of the muscles with fibrillar twitchings, reaction of degeneration, &c.; the former at the outset would be merely a functional disturbance of these centres, conditioned probably by different causes, and expressing itself as muscular dystrophy with all its characteristic symptoms. At the same time, there would remain the possibility that even this merely functional disturbance might in the long run become associated with a coarse lesion of the centres. Many things about these affections would agree very well with such a supposition, among them the occasional occurrence of the reaction of degeneration in dystrophic cases and the occasional initial localisation of spinal amyotrophy in the shoulder and trunk. But I will not spin out this discussion to any greater length; the whole question is by no means yet ready for decision, and the future alone can lift the veil and reveal the finer processes that as yet lie hid from us.

Coming back from this digression to the clinical aspects of the disease, we have yet to say something about etiology. We know very little of its causes. The most certain thing about it in this connection appears to be its hereditary character; at any rate, this holds good for a majority (about three-fourths) of the cases. It not unfrequently occurs as a family disease, and can be traced through several generations; in cases of this kind there can scarcely be a doubt as to the hereditary transmission of the affection, or at least of the predisposition. But it often happens that two, three, or more cases occur in one generation only, and here we may probably assume some influence proceeding from the parents, though it is not necessary to suppose this in every case. Marriage between blood-relations sometimes seems to act as a factor, and in one of my cases the parents are cousins, the children of twin brothers, thus standing in the closest conceivable relationship in which a legal marriage is permissible. In another, the father had suffered from a severe injury. What I found to be of most frequent occurrence was the existence of neuropathic and psychopathic tendencies, but even this was present only in 8 out of 18 families. Many cases occur, however, quite in an isolated way; in certain of these no doubt the history may be defective, but the disease must always make a beginning with someone, and it remains to be seen whether in these instances it is transmitted to the posterity. All the other causes which have been blamed—overstrain, injury, influences affecting the mother in pregnancy (injury, mental agitation), acute infectious diseases, &c.—are of so little relative importance and so rarely present that they hardly deserve mention.

The course is generally a progressive one, though not nearly so much so as in spinal amyotrophy. It is always very slow and insidious, extending over 20 or 30 years, and sometimes coming to a standstill altogether, so that the patients live to a good old age. I have seen individuals between 50 and 60 years of age who had been affected with it when young.

The end comes not unfrequently in this way, that the lesion makes continual progress, spreading to one muscle after another, until the patient becomes at last quite helpless, and with affection of the respiratory muscles and diaphragm death is finally produced by asphyxia or intercurrent disease. The younger the patient when first attacked, the more rapid and destructive is the course of the disease. Other unfavourable elements for the prognosis are the spreading quickly from one part of the body to another and a marked tendency to lipomatosis. But children with the pseudo-hypertrophic form in general attain to a considerable age, though there are exceptions to this.

About the prognosis I have already said all that can be said. Actual recovery does not appear to occur, but I have repeatedly seen the condition improve and the disease even coming to a halt. This occurs especially in cases beginning first in youth or adult life.

In regard to treatment, the outlook is far from encouraging, and the results attained hitherto are extremely meagre. Should the attempt not be made to try some kind of prophylaxis against this disease in the actual presence of which we are so helpless? Should not we subject to some treatment parents, who, without being affected themselves, have already had dystrophic children or who have come of dystrophic families? The object aimed at would be of course to endow any children they might have afterwards with greater strength and power of resistance. It is rational enough to argue in this way, but I cannot see what more we can do beyond following the ordinary laws of health and employing the usual "tonic" remedies. The same holds good of the prophylaxis in the case of children of dystrophic families, whether their parents or brothers or sisters are affected or not; we cannot get further than laying down some general rules about healthy modes of life and good food, general hardening up, fresh air, baths, avoidance of undue muscular strain, tonics, perhaps the use of arsenic; these exhaust the means we have at our command.

For the disease itself we merely possess the old remedies which have so often failed of their purpose. My own opinion is that the application of electricity is still the most trustworthy thing we have. In particular, I would have you use the galvanic current along the back and over the cervical and lumbar swellings of the cord with a regard for the trophic centres lying about these regions, whether you consider them the proper seat of the disease or not. You may, besides, employ peripherally the faradic, galvanic, or farado-galvanic currents to the nerves and muscles, although I must warn you against using too strong currents or having too long sittings. Massage of the affected muscles deserves a trial, but it must not be too energetic. So do gymnastics, but they must be carefully adapted to the condition of the individual muscles as regards nutrition and strength, and, above all, must not be carried too far. In addition, you may employ any of the means which give tone and resisting power to the whole organism. Such are cold baths, sea-bathing, warm salt baths, chalybeate and peat baths, pure air, good food, tonics, arsenic, strychnia, &c,

Gentlemen, I am coming to an end. I have endeavoured to bring before you progressive muscular dystrophy as a perfectly well-defined disease, though it assumes various forms. It is certainly by far the most common of all the progressive muscular atrophies, and the number of the cases that have come under my own notice, reckoning all the forms together, is many times the number of my cases of spinal amyotrophy. I trust, at any rate, I have convinced you of the clinical unity of our "dystrophies," and I am now satisfied to leave it to yourselves, if you choose to distinguish individual forms or subspecies (types) in that unity—a course which is not without its advantages. The division into the pseudo-hypertrophic, the juvenile, and the infantile forms is recommended by its simplicity, and the characters of these forms I do not need to repeat again. It is possible, however, that with advancing knowledge we may arrive at a division still more suitable for our purposes.

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ASTHMA AND DISEASES OF THE GENERATIVE ORGANS.

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ASTHMA AND DISEASES OF THE GENERATIVE ORGANS.

(Asthma sexuale.)

As we all know, the pathology of asthma has already undergone various modifications. For some time past two forms have been recognised: Bronchial Asthma and Nervous Asthma. Under the first we comprehend those cases where an excess of bronchial secretion is present. This forms the well-known three layers of expectoration in the spit-jar: purulent, ropy, and frothy mucus. Examination of the lungs reveals the signs of chronic bronchial catarrh, which is constantly kept up by acute attacks. According to Boeker (German medical weekly journal, No 26 and 27, 1888), asthma is generally caused by the state of the bronchial mucosa. No proper anatomical idea was connected with the expression "nervous asthma"; there was only a vague impression that nervous processes had something to do with its causation.

This view was often questioned by the representatives of the anatomical school of this century. It was held that asthma was no nervous affection at all, but always connected with emphysema and bronchitis, and even Laennec was of the opinion that the chief cause of asthma was catarrhe sec and emphysema.

On the other hand, several authorities on asthma, as Ramadge, Bergson, &c., maintained that asthma cannot be explained without assuming a nervous element.

In later times, however, we know definitely that asthma is a pure neurosis which has just as much a substantive existence as many other nervous affections, *e.g.*, megrim, epilepsy, &c.

Hence, in the light of this knowledge we must regard every case as a symptom of some underlying disease, and must direct our attention, as regards ætiology, to the nervous processes, however obscure.

The onset of an attack of asthma is explained by irritation of the central nervous system, wherever the path lies the origin is the same: the nerve endings are morbidly irritated and transfer the irritation to the central organs.

This irritation may be produced either through catarrh developing in the vicinity of the nerve endings, or through hyperplasia of the surrounding tissue, or through dry atrophic catarrh, which destroys the respiratory mucosa in places, thus rendering the nerve endings more sensitive, or through derangement and obstinate catarrh of the stomach affecting its nerve supply, or through emphysema, bronchial catarrh, caseous bronchial glands, &c., any of which cause chronic irritation of the bronchial nerves, or through diseases of the ovaries, uterus, vagina, prostate, bladder, penis, (at times the glans,) any of which may establish nerve irritation. All these various affections may produce asthma. (Asthma: its nature and treatment. Brügelmann.)

Asthma may occur as a neurosis pure and simple, but it is much more frequently observed in connection with congestion and catarrh of the respiratory mucosa. The nerve which is generally assumed to be implicated in the production of spasm is the vagus. However, the sympathetic appears to me to be more likely, for although we may not have sufficient grounds for this, still from analogous distribution of the sympathetic to unstriated muscle there is nothing strange in inferring the bronchial muscular fibres to be similarly supplied.

It might, therefore, be held that there is but one form of asthma, namely, that which arises through nerve influence. But for practical reasons it is better to classify the various forms of asthma according to the seat of irritation. Brügelmann makes the following division:—

(*a*) Nasal asthma.
(*b*) Pharyngo-laryngeal asthma.
(*c*) Bronchial asthma.
(*d*) Toxic asthma.
(*e*) Neurasthenic asthma.

Under neurasthenic asthma all those forms are included that do not fall under the other divisions. He would therefore include those cases about which I intend to say a few words, namely, asthma dependent upon sexual affections. These are not by any means so seldom as has hitherto been assumed, as will be seen in the course of my remarks. I might almost maintain that the generative system is one of the chief seats of irritation producing asthma, and divide asthma into six classes, of which sexual asthma forms one.

This division has a further practical bearing as plainly indicating the chief exciting cause of asthma, which is generally overlooked in the examination of the patient, either from ignorance or false modesty on the part of the physician or of the patient.

In not a small number of cases, we find, in males as well as in females, disorders of the generative organs, which produce attacks of asthma through the medium of the sympathetic nervous system.

But in the male sex, particularly, these disorders are much more frequent than has hitherto been thought. They are chiefly affections of the posterior portion of the urethra which cause reflex nerve troubles, *e.g.*, urethritis posterior in consequence of sexual excess, masturbation, gleet, &c., and spermatorrhœa, though affections of the penis, especially of the glans, may also play an important part.

If we, then, admit a sexual asthma, we must carefully enquire into the generative functions in the presence of negative results from other causes, otherwise we are liable to errors of omission.

This examination is very troublesome and tedious, as only an exact and painstaking history of the case and repeated microscopic examination of the urine yields safe conclusions as to the pathological condition of the generative tract. Even endoscopy may be necessary to be quite certain of the diagnosis.

My object is now to bring forward a number of important cases illustrating the significance and influence of sexual derangements, especially in the male, in the causation of asthma.

Various views are entertained as regards the immediate mechanism of a paroxysm of asthma. Biermer's explanation is the most probable, according to which a spasm of spastic narrowing of the bronchioles takes place. Inspiration and expiration are in consequence interfered with, but especially the latter, as the effect of the bronchial spasm is considerably increased by the expiratory pressure.

There is, however, another variety of asthma where inspiration is impeded or rendered impossible for a time through clonic spasm of the diaphragm (phrenic asthma).

The thorax remains some seconds fixed in the position of inspiration, the epigastrium is arched forward, the heart depressed, and the spasmodically-contracted diaphragm can be felt. Patients suffer frequently from great oppression on the chest and pain in the diaphragmatic region. These cases are, as a rule, less numerous than those of bronchial asthma, and seem to me to occur more often in women.

However, bronchial and phrenic asthma can be very easily distinguished, and no one who has seen a typical case of either will have any difficulty in diagnosis. Both kinds may be caused by sexual affections.

CASE I.—*Severe Asthma in consequence of Masturbation in Youth, and later on Spermatorrhœa—Cure.*

In 1871, as family medical attendant, I was called in to see Mr. A., inn-keeper and farmer. He was 26 years old, married, and had two children. Bodily strength well developed, temperament lively, and habits very regular. For a year past he frequently suffered from slight bronchial catarrh and from several severe attacks of asthma.

History: Patient's father suffered in later years from chronic bronchial catarrh and emphysema; his brothers and sisters, four altogether, were quite healthy, and, with the exception of measles, Mr. A. had never had any other illness. When 18, he became steward to a farmer, and it was then he first had an attack of asthma, which recurred some four times in the course of the next two years. On this account he was exempted from military service. During the following four years he actively pursued his farming duties and enjoyed excellent health. He then married, and also undertook the management of an inn. He ascribed his no longer feeling so well, and his sallow muddy complexion, to the want of his former out-door occupation, and attributed his susceptibility to catarrh, which, as above mentioned, was accompanied by attacks of asthma, to being frequently in his vaults. These attacks became more frequent, patient lost flesh, and was sent by his medical advisers to Davos, under a strong suspicion of tuberculosis. During a two months' residence there, he gained twenty-five pounds (27½ lbs. Eng.) in weight, his appearance became normal again, he lost the catarrh, and no more asthmatic attacks occurred. He was able to do plenty of mountaineering without the least fatigue. He had scarcely returned home, when the attacks came on again. In the summer of 1872 he went back to Davos for a longer course of treatment, in spite of which he again experienced several attacks at the beginning of winter, and consequently spent the whole of that winter (from 1872 to 1873) at Davos. The following summer he remained quite free. In the autumn, however, they reappeared, and so severely and frequently that he had to give up his inn and retire. Notwithstanding these steps, there was no improvement, and on my advice he consulted my former teacher, Professor Biermer, of Zürich, who reported as follows on the case:—

"Mr. A. suffers from chronic dry bronchitis and consequent emphysema. The cardiac dulness is much diminished owing to encroachment of the lungs; vesicular breathing cannot be heard in several areæ, or is replaced by dry râles. The asthmatic attacks are produced by spastic narrowing and catarrhal swelling of the bronchioles. I recommend potassium iodide as a well-tried empiric remedy."

At first he obtained some relief from the medicine, and had it made up some sixty times in the course of a year. Unfortunately he was worse than ever in the autumn of 1874. The asthmatic attacks increased terribly, and he did not venture to go out without respirator, or without being muffled up to the ears in woollen wraps.

The thought occurred to me now, for the first time, that these attacks might have some connection with the sexual functions, from what the patient casually told me when called to see him one night in an attack. He remarked that he thought sexual connection was harmful to him, and that he would have to give it up, as he was almost certain that it always brought on an attack.

From this communication, I carefully inquired into the sexual functions of the patient from his youth, and obtained the following statement: From boyhood he was much addicted to masturbation, and practised it continuously up to manhood. At school, when greatly excited (*e.g.*, when he had quickly to work out a difficult sum before the teacher) seminal emissions would occur with the penis quite flaccid. Later on these took place when simply coming into contact with women. Nocturnal emissions occurred without erection or awaking him. Several attempts at sexual intercourse completely broke down, either from defective erection or from precipitate ejaculation. In his marital relations it was just the same; even if penetration was effected, ejaculation immediately occurred; and his wife stated she had never experienced the sexual orgasm, and therefore was very much surprised at conceiving.

The penis was small and flabby, and the glans was completely covered by the long prepuce. The meatus was greatly reddened, the mucosa tumid, and the introduction of a bougie caused unusual pain. Frequent examination of the urine, which chemically was normal, revealed almost invariably traces of semen. Biermer, like the preceding medical men, diagnosed pulmonary catarrh and emphysema.

"The asthmatic attacks are produced by catarrhal swelling and spastic contraction of the bronchioles," so Biermer states.

At that time I certainly and quite naturally thought so too. But what is the origin of this spastic contraction (*i.e.*, the paroxysm, which determines the nature of asthma)? What is its cause? Along which nerve path does it travel? And last, but not least, to the practical physician, will it yield to treatment?

At that time, about 1870, asthma was not regarded as a nervous disorder, and still less was the idea ever entertained that it could be brought about reflexly by affections of the generative organs. Yet, for an observing practitioner, the probability of this causal connection in the above case lay quite close at hand. For we have here defective sexual power, typical spermatorrhœa, and asthmatic attacks following and brought on by sexual connection. At any rate I resolved upon local treatment of the spermatorrhœa. This consisted in the prolonged use of a metallic bougie for some minutes at a time, and of astringent injections. As regards the ultimate result I can only state that the patient since then, some 15 years now, has remained quite free from asthma.

CASE II.—*Temporary Aspermatismus, followed by impotence. Spermatorrhœa. Neurasthenia. Severe Asthma.*

In July, 1880, Mr. R., a miller, consulted me on account of severe asthma and a distressing feeling of depression. Patient was 48, medium height, well built, muscles well developed, and body well covered. He had five children, the youngest being ten years old; no symptoms of hereditary disease. He was accompanied by his wife, a very intelligent woman, who volunteered the following statement: "Doctor, I shall just tell you the cause of his illness; my husband has been completely impotent since he was 38 years old, and even before he was never quite right in this respect." Following up this remark, I inquired into his past *history* and obtained further particulars about his sexual habits. Ever since the age of six he was addicted to masturbation; ejaculatio seminis took place first when he was 15, and from then up to 20 he generally masturbated some four or five times daily. When 18, shyness and attacks of depression appeared, but usually passed off quickly. He himself referred them to his vicious habits, which he nevertheless continued, although not quite so frequently, up to 26, when he married. Erection did not always occur at the time of coitus and then the patient had to resort to manual friction. From the very first, ejaculation had absolutely never taken place during natural coitus. After repeated intra-vaginal friction the penis lost erectile power without ejaculation occurring. In fact, under no conditions did ejaculation follow connection. He, therefore, aided the process by withdrawing the penis after more or less vaginal friction and then manually excited it until ejaculation was imminent, whereupon he quickly reintroduced the organ. In this way Mr. R. begat five exceptionally vigorous and mentally and bodily healthy children. When 38, in spite of great bodily strength, he completely lost sexual power, and from that time his present illness first began to assume a definite character. His wife mentioned this when he first consulted a doctor, and added she drew the attention of the different medical men he saw to this circumstance, none of whom, however, attached any importance to it. The above-mentioned attacks of dread and depression, which had never quite left him since his 18th year, became frequenter and lasted longer. Periodic attacks of profuse perspiration, commencing when he was 20, which exempted him from military service, increased in spite of a naturally cheerful disposition. Strange fixed ideas took hold of him, which he could not get rid of, although quite convinced of their absurdity. For instance, the idea oppressed him that his inside was not formed like other people's, and his first thought on seeing a stranger was what his inside might be like. Then he gradually got to believe, without the slightest reason, that he squinted with the left eye. He kept constantly looking in the glass, and, notwithstanding the evidence of his own senses and the assurances of the ophthalmic surgeon he consulted that there was nothing wrong with his eyes, he could not get rid of this impression. Another idea was that he had a cough, and no arguments of his friends were sufficient to disabuse his mind. However, it was only within the last year that his symptoms attained a serious degree. His despondency became so intense that he did not trust himself to be alone; even when taking a short walk he would have his wife and daughter accompany him. If asked how he was, his eyes filled with tears, and he cried before strangers just like a child. Sleep, which had formerly been good, had been disturbed during the last few years; now it was wretched, and he scarcely slept more than two or three hours, and then was troubled by oppressive dreams. He used to be an untiring worker; he was now always languid. Perspiration was so profuse that when he only stooped he became literally bathed in sweat. His fancied cough was now a reality, and pretty severe asthma was present. He could only go up a short flight of stairs with difficulty, and then had to rest for some moments before he could speak a word. At night he spent hours sitting on a chair in order to obtain breath, and was consequently terribly afraid of going to bed at night. The attacks became severer and more prolonged. They came on without the slightest provocation, and were at times so intense that the patient, with body bent forward, cyanosed features, and thick swollen veins of the neck, clutched hold of the table, struggling for breath. This was his condition when he came under my care. Up to that time he had been treated by several medical men for the lung affection and all his sufferings were referred to asthma. Shortly before a professor of medicine had recommended him to go to Corsica, but, not feeling strong enough to do so, he spent two months in Gersau (Lake of Lucerne), where he obtained no relief. On examination I found moderate bronchial catarrh and well-marked emphysema. The somewhat scanty frothy expectoration revealed under the microscope asthma crystals, like the spines of a hedgehog.

The urine contained neither albumen nor sugar, but almost every time a varying amount of semen could be detected, along with urethral mucus, although the patient never had gonorrhœa.

I diagnosed severe neurasthenia, reflex asthma depending upon chronic posterior urethritis, and spermatorrhœa. Treatment, which was chiefly directed to the primary affection, confirmed the diagnosis. The patient completely recovered and has since remained well.

Case III.—At the end of February, 1883, Mr. F., teacher in Z., in the Black Forest, Baden, came under my care. He was 26 years old, very tall, broad shouldered, big-boned, with well-developed muscles (Mr. F. served in the Guards), but looked pale and anæmic.

He complained chiefly of a peculiar form of coryza and periodic attacks of asthma. The former, for the last five years had regularly occurred twice a week and on definite days, Wednesdays and Saturdays. On each preceding evening prodromata manifested themselves, consisting in general malaise, a feeling of heaviness in the head and of oppression on the chest; frequent sneezing ensued and a tenacious mucus was secreted from the nose.

The same night the patient was restless, had troubled dreams, and awaked in the morning unrefreshed. The nasal mucosa began now to secrete a watery fluid, the eyes kept on filling, and violent sneezing occurred incessantly.

The sneezing at the nose was so copious that Mr. F. often used ten pocket-handkerchiefs a day, which became dripping wet.

Towards evening the nasal discharge abated considerably, but the sneezing was still frequent. The night was passed undisturbed, the next morning on waking he felt refreshed, and the attack was over.

This recurred in an exactly similar manner in the same week.

In the interval between the attacks there was no nasal secretion, and the patient did not use a handkerchief at all.

It must, however, be mentioned that on the coryza days the feet were markedly dry and hot, and gave rise to a burning sensation; otherwise the patient's feet perspired normally.

The sense of smell was completely lost during an attack, but in the interval was quite normal.

About a year after the commencement of the coryza, *i.e.*, about four years ago, the above-mentioned asthmatic attacks supervened, but only in connection with certain events.

Mr. F. was a heavy beer drinker. One evening, in company, he had taken his 10 to 14 glasses of beer, which he could always very easily stand, when the next day, on the slightest exertion, he suffered from difficulty of breathing, which considerably increased during the next six months. For instance, if he wanted to do a little gardening, or quicken his steps on level ground, an attack would come on, which finally reached such an intensity that he was obliged to remain bent forward, seizing hold of any fixed object to get his breath.

As above stated, asthma at first only appeared at times after excessive drinking. If he avoided excess he could walk as usual and even climb a hill without any difficulty.

As this affection was first manifest during the hay-harvest, his medical advisers regarded it as "hay-fever." The diagnosis really seemed to be correct, for in the next winter the attacks were much less frequent, and only occurred after heavy drinking.

The following summer, however, they grew severer, and at times were so severe that owing to difficulty in breathing the patient could scarcely walk 50 paces on level ground without having to rest. Consequently he gave up beer drinking, the immediate cause, as much as possible. His usual amount for a few years past had been two bottles a day, and as a rule he took no spirits. He also became more moderate in smoking, having previously been a very heavy smoker.

He also had noticed latterly that slight excess in drinking and smoking completely knocked him up, and he suffered considerably from after-effects, as he had never done before.

Furthermore, he had lately lost appetite, which was formerly excellent, and instead, had a sensation of sinking and depression. He felt the need of taking food, but had no inclination for it when placed before him.

Formerly the bowels had acted regularly, but during the last two years their action became noticeably frequent. At first twice, then four to five times a day, with regular intermissions. Then periods occurred when he had severe diarrhœa—12 to 15 evacuations daily—lasting from one to two weeks without any apparent cause. Treatment had but a temporary effect and it usually ceased of itself.

On various occasions Mr. F. had been troubled with worms, and he vomited a large one a short time ago.

He had been married a year, and recently his wife was confined of a healthy child.

Physical examination revealed tolerably marked anæmia, faucial catarrh, slight chronic enlargement of the tonsils, a swollen, bluish red, pendulous uvula, and moderate pulmonary emphysema. On rising the patient always hawked up a scanty phlegm; he seldom coughed. Heart and abdominal organs normal. Chemical examination of the urine revealed nothing abnormal; at the bottom of the urine glass a slight cloudy sediment settled, which I unfortunately did not examine microscopically, as, from the history of the case, I thought there was no indication for it.

Diagnosis. First and foremost I sought a connection between all the symptoms which would present a complete picture of the disease, and proceeded thus. Here we had for several years past chronic gastric and enteric catarrh, as shown by loss of appetite and constant diarrhœa, caused by immoderate drinking and smoking. The enteric catarrh was probably kept up by the presence of worms, which had been noticed several times. The chronic faucial catarrh, hypertrophy of the uvula, and chronic tonsillitis were likewise referable to his smoking and drinking. The almost periodic attacks of nasal catarrh I could not account for; I had never seen anything similar before. In any case, however, I regarded it as connected with the chronic faucial catarrh.

There was in all probability a causal relationship between the gastric catarrh and the asthma; the latter I regarded as a reflex nervous affection. This view was corroborated by the attacks coming on after excessive drinking, and also perhaps, as I thought, by the presence of worms in the alimentary canal. From the very first the presence of pulmonary emphysema and of the chronic inflammatory condition of the fauces predisposed the patient to them.

On this diagnosis I based my treatment. At the outset, diet was strictly regulated and the amount of drink taken was limited to two glasses of light good beer daily. Smoking was forbidden and an energetic course of santonin was carried out.

Fifty-four days after I saw the patient again; his condition was about the same, appetite slightly better, no worms had been found.

Local treatment of the nose and throat, and various internal remedies were used, but without any result, and during the two months he was under me the patient received no benefit worth mentioning.

In the course of conversation one day Mr. F. told me, incidenally, that he was still obliged to pass water very frequently, and at times experienced a slight burning sensation.

He had already mentioned this fact at the first examination, but, as I regarded it as a result of his heavy drinking, I did not pay any attention to it. But now, as he had given up drinking, I concluded that Mr. F. was suffering from irritable bladder (on idiopathic irritability of the bladder by Peyer, Enke Stuttgart, 1888), and therefore determined to examine the urine again. He passed water in my presence and I again observed the deposit of a slight cloud similar to what I had previously noticed, but unfortunately not examined microscopically.

The chemical examination gave, as on the first occasion, a negative result. On the other hand, a microscopic examination of the sediment, after a little trouble, revealed a fair number of spermatozoa, mucus-filaments, and a few hyaline casts.

In consequence of this discovery, I filled in that part of the *history* of the case which, unfortunately, from motives of delicacy, is generally neglected by medical men, and questioned him as to the condition of the sexual system. The patient then told me that from very early youth, about the 10th year, he was led to masturbate, and constantly practised this vice till he was 18. About this time he obtained a post as teacher, and also became acquainted with a woman with whom he had intercourse very frequently, until his marriage some 15 months ago.

For a long time he did not notice any injurious effect from excessive sexual indulgence, until some four years ago, when he had nocturnal emissions in spite of frequent sexual intercourse. At first they occurred about once a week, then more often, until in the same night he had connection and later on seminal emissions. In the morning he was dreadfully tired and played out, and suffered slightly from shortness of breath. In the last two and a-half years intervals occurred—and recently more frequently—when regularly, for a week at a time, he had nocturnal emissions, in spite of frequent sexual connection.

Sexual desire had considerably decreased. Erection took place readily enough, followed almost by immediate ejaculation; and it was only when the patient had drunk freely of beer, in spite of long-continued friction, that no discharge of semen took place, and the erection passed off—in other words temporary aspermatismus. The sexual orgasm accompanying ejaculation had almost completely disappeared.

Several specimens of urine the patient sent me always showed the same characters—more or less traces of semen, at times hyaline casts (testicle casts) as above mentioned, and a few lymph corpuscles.

I altered my diagnosis, and considered the case to be neurotic in nature, one of nervous erethism or neurasthenia, brought about by early-commenced and long-continued sexual abuse. The periodic nasal catarrh, asthma and chronic diarrhœa were nervous or reflex in nature, and depended upon the sexual disorder. The frequent micturition represented the so-called irritable bladder, and was due to an inflammatory condition of the neck of the bladder, which had extended from the prostatic portion of the urethra.

The correctness of the diagnosis was proved by the result of the local treatment of the uro-genital tract.

The nervous coryza, asthma, and chronic diarrhœa disappeared completely in the course of half a year, and no return occurred.

CASE IV.—*Spermatorrhœa. Severe Spinal Irritation. Asthma.*

Mr. H., farmer, well-to-do, 35 years old, exceedingly robust, who served with me in the same regiment, consulted me in May, 1883, on account of pain in the back and asthma.

His habits were very regular and industrious; parents healthy and strong. He had never had any real illness, had been seven years married, with three children, the youngest being three years old. About four years ago he noticed for the first time a certain oppression and stiffness in the back, especially after hard work. Gradually the pain became at times so severe that he could neither move his body nor stir from his position, not only after hard work and heavy muscular exertion, but even whilst quietly walking or sitting. He even felt his back when lying down. At that time also severe asthmatic attacks appeared without any apparent external cause. They seized him in bed, at work, or when walking quietly along the road; he was then obliged to remain standing. Later on asthma came on almost daily, at one time lasting from five minutes to a quarter of an hour, at another lasting half a day. No cough and no expectoration. When I saw the patient, his digestion was disturbed, appetite variable, never good; frequently a sense of fulness and distension after meals; bowels sluggish; no emphysema; frequent desire to micturate, withal difficulty in starting the stream, which was not forked. Since his illness began he suffered a good deal from headache; during the morning his head was heavy and he felt giddy. Memory good as a rule, no depression of spirits; constant lassitude, sleep heavy, dreams rare but oppressive. For some time past he had felt remarkably little inclination for sexual intercourse; in fact, after coitus he felt quite exhausted, could not speak, and fell into a heavy sleep, only to awake with a severe headache in the morning. Examination of the urine revealed nothing abnormal, except now and then the presence of semen.

Local treatment of the sexual affection cured the asthma and spinal irritation.

CASE V.—*Impotence. Spermatorrhœa. Asthma.*

In October, 1877, Mr. L., merchant, ætat. 30, consulted me for general debility, heaviness of the head, persistent loss of appetite, nausea, frequent vomiting, weakness of memory, and periodic severe attacks of asthma.

History. No hereditary taint; two years ago he was quite well, and, in fact, had never had any serious illness. When 15, through bad example, he began to masturbate, and continued to do so more or less up to the present time. When 21 the patient for the first time endeavoured to have connection, but, in spite of all efforts, did not succeed in obtaining an erection. Half a year later he succeeded, but ejaculation took place immediately on introduction. This occurred with every subsequent coitus, whenever the attempt was thus far successful. He noticed that when he was about 26, during his attempts at connection he sometimes suffered from slight asthma, which, however, soon passed off, although he was never troubled with any difficulty of breathing, even during heavy walking. About two years ago he awoke in the night, greatly alarmed, and unable to get his breath. He sprang out of bed, rushed to the window in order to get air. His medical attendant, who was hastily summoned, prescribed him a full dose of morphine, which relieved the paroxysms, only to recur in the same night. Mr. L. was consequently so weak that he was obliged to remain in bed for a week, and suffered a good deal from palpitation. For some weeks afterwards he felt very weak on his legs. For a whole year he remained quite free from an attack; in the course of the last year, however, four serious paroxysms occurred. He began to lose flesh, was always languid, especially in the morning, his head felt heavy, and he was much depressed in spirits. His memory became much weaker, appetite was completely wanting, nausea and frequent vomiting occurred, the bowels were sluggish, and his gait was peculiarly unsteady. About half a year ago, he felt while walking a dull heavy pain in the left testicle, which was present later on, even when sitting. He fancied he must have unconsciously squeezed the organ. Physical examination of the thin, slender built, anæmic looking patient revealed nothing abnormal beyond slight emphysema. There was nothing noticeable about the painful testicle,, the scrotum was lax and the penis flabby. Chemical examination of the urine showed nothing abnormal, although microscopically numerous spermatozoa could be detected in almost every specimen.

Under treatment, which from the nature of the circumstances was purely local, the symptoms completely vanished. Nausea, vomiting, and loss of appetite disappeared first, normal appetite and regular action of the bowels returned, and in quite a short time the patient gained 7 kilograms (15 lbs.). Spermatorrhœa ceased, nocturnal emissions occurred normally, and his gait became steady again. About two years after the end of treatment I heard from Mr. L. that he was quite well, the sexual functions quite normal, and he had no trace of asthma.

CASE VI.—*Long-continued Sexual Abuse. Asthmatic Attacks, especially after Coitus.*

In September, 1883, Mr. M., commercial traveller, consulted me for very troublesome attacks of asthma, which came on once or twice a week. He was 28 years of age, of medium height, well developed, and looked healthy. He was a heavy smoker, and, from the nature of his occupation, drank more than was good for him. Frequent matutinal sickness, appetite and digestion otherwise normal, sleep good. About two years ago he had the first attack of asthma, although during the whole of his military service as foot soldier he bore the greatest fatigue without any discomfort.

The first attack came on after sexual connection, and up to the time of observation he almost regularly suffered in this manner.

As regards sexual intercourse the patient stated he had but little desire, in fact ejaculatio seminis occurred almost immediately on attempt at coitus, and moreover an asthmatic attack would follow so regularly that coitus almost became impossible. He gave a *history* of long-continued sexual abuse, and, in consequence, frequent nocturnal emissions.

Physical examination revealed slight faucial catarrh with moderate emphysema. Urine, which was only examined once, was normal. I did not see the patient again, who only happened to consult me whilst on his travels.

CASE VII.—*Temporary Aspermatismus. Asthma.*

Mr. K., farmer, ætat. 59, a tall, somewhat thin and anæmic man, suffered for some years past from periodic asthma, which occasionally was followed by slight feeling of "oppression." Generally these attacks came on after sexual intercourse, which had undergone a peculiar modification.

When 40, he married quite a young lady, who bore him four children in quick succession.

The first stage of coitus was normal, but he no doubt indulged too freely, and ascribed to this circumstance the fact that at times no ejaculatio seminis took place. After such an occurrence, in the course of 24 hours, he experienced a burning sensation in the urethra, which was particularly severe when passing water.

On the first occasion of this sexual anomaly, asthma appeared. There was slight pulmonary catarrh and emphysema present. The relation of the two complaints in this case was very apparent, and I at once examined the genital system. The organs were normal in shape and showed no external sign of weakness or inflammatory irritability. No history of sexual infection. Examination of the urine revealed slight urethral irritation and at times spermatozoa.

Local treatment very soon improved the sexual powers. Ejaculation accompanied connection, and the result was a healthy boy.

At the same time the asthma completely disappeared.

At the end of 1885 I saw Mr. K. again; his wife had recently been confined. He said he had noticed latterly premonitory symptoms of his former trouble, ejaculatio seminis failed to occur during coitus, and now and then an attack of asthma came on.

Resort again to local treatment improved his condition, and cure now was permanent.

CASE VIII.—*Masturbation during Youth; later on frequent Nocturnal Emissions and Coitus Reservatus. Frequent and Severe Attacks of Asthma.*

Mr. F., lawyer, ætat. 38, a tall, well-built man, pallid complexion, was up to 14 years of age a healthy-looking lad. He was an only child; his father, a strong man, died, ætat. 52, from kidney disease; his mother, an extremely delicate and nervous woman, succumbed to lung disease, ætat. 50.

As far as his memory went, he said he was always of an imaginative turn of mind, especially in sexual matters. When 14 he accidentally became addicted to masturbation, which he practised continuously for the following six months. His parents admonished him to give up the pernicious habit, which he did, whereupon frequent seminal emissions occurred, often three or four nights in succession, and almost always towards morning. With the object of combating this state, the patient used an alarum. If he set it for five in the morning, this was effectual once or twice, but afterwards seminal emission would take place at a quarter to five. If he set it still earlier, *e.g.*, at four, his waking did anticipate matters for a few days, but subsequently seminal discharge would occur from a quarter to half an hour before. At times the alarum and the seminal emission coincided.

Internal medicine, milk diet, change of air, sea bathing, abstinence from highly-seasoned dishes, from alcohol, tea and coffee, had no influence over his condition, and just as little had regular intercourse, to which he later on resorted, on medical advice, as a last resource. After leaving school, Mr. F. entered the army in order to have as much out-door exercise as possible. When 22, at the close of the great autumn manœuvres, which he had gone through without any great trouble, he was suddenly attacked, during the night, by asthma. He sprang out of bed, flung open the window and gasped for breath; it was not till after some hours that the dreadful state yielded; henceforward the paroxysms happened more frequently.

Several medical men noticed slight emphysema, and attributed the asthma to this condition as well as to the strain of campaigning. He consequently resigned his commission in the army, and carried out his primary intention of studying law. As Mr. F. was well-to-do, and engaged, he married soon, and then, in order to prevent children, practised coitus reservatus. His marital life had no influence on his general health, nocturnal emissions still persisted, asthmatic attacks were in fact very troublesome during the next six years, which he spent partly in Carlsruhe and partly in Rastatt. At the former place they were so severe that he often thought he would suffocate.

As a rule they came on during sleep and at night; if they were but slight, or if he only felt prodromata, burning nitrated paper or hot application always brought relief. When they were at all severe he had to be propped up in bed with five or six pillows, or was obliged to get up and sit bending over a chair. "He had passed many such terrible nights thus, coughing, wheezing, spitting, and gasping for breath, half suffocated." Chloral alone relieved this condition; morphine was less beneficial.

He had *not* noticed any direct relation between sexual connection and his sufferings. Local treatment which the patient underwent, when 28, for nocturnal emissions had not the slightest influence upon them or the asthmatic attacks.

Now, however, that I recognise the evil consequences of frequently-practised coitus reservatus, I ascribe the failure of my treatment to this factor, and although the patient told me of it, I did not forbid it.

Later on the patient gave up this practice for various reasons, and treated himself for the nocturnal emissions by administering a cold water enema just before retiring. Gradually his sexual troubles disappeared, and his asthma got well, after having lasted some 16 years.

CASE IX.—*Severe Asthma in a Young Lady brought on during Coitus.*

In the summer of 1884 I was called during the night to attend the young wife of a French officer, who was staying at the well-known Schweizerhof Hotel, at Rhinefalls, on her wedding tour.

On arrival, I found the patient, ætat. 20, who was fair, somewhat delicate and anæmic looking, out of bed, sitting in an arm chair, and suffering terribly from want of exspiratory power. Her husband informed me that they only arrived at Rhinefalls two days ago, and that in the latter part of the same night asthma appeared. Four days ago the young couple had been married at Brussels, the home of the bride, and had left immediately for Cologne, where, on consummation of the marriage, his wife, who had no idea that she was asthmatic, had a paroxysm for the first time. It was not, however, serious, and did not last long. The following night a severe attack occurred again during sexual connection, which lasted in varying intensity some two days. Then, on arrival at Rhinefalls, during the third intercourse, the severest attack of all came on, in which I found the patient, and which lasted, varying in degree, some eight days. In fact, it was so serious that I was obliged to spend three whole nights with the patient.

In the course of conversation, Captain O. told me that his wife had suffered a good deal from chlorosis, nervousness, and leucorrhœa. During sexual intercourse she is exceedingly excitable; sexual orgasm very soon occurred with her, whereas he was of a remarkably sluggish nature, and a considerable interval elapsed before ejaculation. Afterwards she was completely done up, whereupon the breathing at once became laboured; the genuine attack did not come on until some hours after.

When she was able to undertake the return journey she passed from under my care, but I impressed upon her very strongly the advisability of consulting a specialist for diseases of women, and submitting to a thorough examination of the sexual organs, which were in all probability in a condition of inflammatory irritability.

CASE X.—*Masturbation. Hyperaesthesia of the Orificium Vaginae. Vaginal and Uterine Catarrh. Hysterical and Asthmatic Attacks.*

One of my acquaintances consulted me shortly after marriage about his being unable to have connection with his wife. No sooner did he touch the genitals when she became greatly excited, hysterically convulsed, and swooned away. She was 24 years old, very intelligent, delicate, nervous, and yet excelled in certain forms of exercise, *e.g.*, riding. From time to time she suffered from hysteria and fits, as above mentioned, followed by dead faints, and at times from asthmatic attacks, lasting some hours. There was no pulmonary emphysema present. Digital examination brought on attacks similar to those on attempt at connection. Consequently, this could only be satisfactorily carried out under anæsthesia. It was found that inflammatory irritability of the ostium (orificium) vaginæ was present, hymen absent, vagina dilated and inflamed, and catarrh of the cervix uteri.

Diagnosis: Inflammatory condition and hyperæsthesia of the whole genital tract, due to long-continued masturbation; hence the hysteria and asthma.

Therapeutics: Local treatment, and prohibition of any attempt at sexual intercourse. Complete cure.

CASE XI.—*Fibroid of the Uterus. Severe Asthma. Operation. Cure.*

The patient, ætat. 49, had been suffering for years from severe asthma, which occurred more frequently during summer. She had had five children, and formerly never suffered from any disturbance of the menses. For some time past the periods had been persistently profuse, which she attributed to the change of life. As she had been undergoing treatment for a considerable period without any result, and the lungs were quite healthy, with the exception of slight emphysema, I proposed a vaginal examination, which, however, was declined.

A year later, one of my colleagues informed me that she consulted him, and was then vaginally examined. A fibroid about the size of the fist was found protruding into the vagina. This was removed; the menorrhagia and the asthma ceased.

Other writers have reported cases where displacement and catarrh of the uterus, leucorrhœa, &c., were at the bottom of the attacks of asthma they suffered from.

That form of asthma, due to spasm of the diaphragm, seems to me to be particularly frequent in women.

I have observed a number of such cases, more or less marked, two only of which I shall briefly mention as typical in every respect.

CASE XII.—*Phrenic Asthma. Uterine Catarrh.*

A. M., ætat. 17, native of the Black Forest, Baden, good complexion, and in comfortable circumstances, had been suffering from depression of spirits, shortly after the appearance of the menses, between 15 and 16. Her mother and brother were also liable to fits of depression (slight melancholia). She was given to weeping, apparently at nothing, and was always moody. When she was about 17, slight attacks of asthma came on at varying intervals during the day and night. She said she felt great oppression on the chest, and wanted to take a deep breath; the attempt did not succeed, and inspiration became impossible, causing her great fear and alarm. When in bed she had to sit up, kneel forward, and then recline. All at once she managed to draw in a breath, and immediately she felt all right again. However, by degrees these attacks became more frequent and intense. For quite half the day and night she suffered dreadfully for want of breath. Unable to breathe properly she became almost maniacal, springing out of bed and knocking everything about her. In the intervals she was confused and melancholy. No remedies did her any good.

About this time she became pregnant by her lover, and her symptoms completely disappeared. She married and bore a healthy child. During the whole of pregnancy she remained perfectly free from any distress of breathing. Shortly after, however, it returned, gradually increasing in severity. The presence of leucorrhœa necessitated a vaginal examination, which revealed chronic uterine catarrh. The patient also stated that she suffered, when single, a good deal from "whites." Local treatment of the uterine affection also cured the asthma.

Mrs. G. has since remained quite well.

CASE XIII.—*Chronic Metritis. Phrenic Asthma.*

The second case is that of a peasant woman, ætat. 52, widowed for about 10 years. She had had four children; ceased to menstruate some five years ago without any troubles worth mentioning. About the same time difficulty of breathing commenced. Whilst working, or during animated conversation, or in bed—in fact, at any time or anywhere—the patient, who was robust, well-nourished, but slightly anæmic, would feel at times a weight on the chest which compelled her to take a deep breath. To her terror she noticed she could no longer breathe in deeply; she became alarmed; blood rushed to the head and she was greatly agitated. Suddenly she succeeded in inspiring deeply, the oppression vanished, and the patient was quite well again. These attacks would come on some five or ten times a day, but sometimes not for several days together. There was, moreover, well-marked globus hystericus. Different medical men and the patient herself attributed the main cause of her troubles to a fall down-stairs which happened some years before.

My personal experience and the presence of the globus hystericus rather induced me to refer her illness to some uterine trouble.

Examination revealed a somewhat enlarged uterus, and leucorrhœa. Local treatment, systematically carried out, of the uterine affection alleviated, and finally cured, the asthma.

CASE XIV.—*Masturbation. Gonorrhœa passing into Gleet. Seminal Emissions. Phrenic Asthma.*

Parents healthy, as also two brothers and a sister. When a boy, from 8 to 14 years, the patient suffered from earache and poverty of blood; the latter was the cause of languor and palpitation. When 17 he went to business; there, through bad example, he learnt masturbation. A year after he began to suffer, as a consequence of this vicious habit, from headache, which was chiefly frontal and worse in the morning on rising. Although he gave up the practice after a few years, nocturnal emissions kept on frequently occurring, and at last were, towards his 20th year, of almost nightly occurrence. Headache became more troublesome, general lassitude and weakness were noticeable. Shortly after 20, he went to Marseilles, and there he had sexual intercourse about once a week on the average. Nocturnal emissions in consequence almost ceased, headache also became much less troublesome. On the other hand, other symptoms gradually appeared, the bowels became sluggish, and he suffered almost daily more or less from heartburn and asthma. The latter chiefly occurred during the day whilst sitting at the desk. He felt an oppression on the chest, which gradually became severer and prevented him from drawing his breath. He was then obliged to get up and pace the room, in great anxiety, when all of a sudden he succeeded in inspiring, whereupon the asthma and anxiety disappeared, only however to recur after a time. During the night he was, as a rule, perfectly free. In the course of a year the affection grew considerably worse, and headache reappeared; failing memory and general debility induced Mr. G. to return to Switzerland. It should also be mentioned that, towards the close of his stay in Marseilles, he got gonorrhœa, which however disappeared fairly quickly, leaving behind a tendency to nocturnal emissions. In addition, diurnal emissions —without erection of the penis—occurred, brought on by mere stimulation of fancy. There was a constant desire to pass water, with a burning sensation along the urethra, and later on headache was often accompanied by giddiness.

This was the condition I saw the patient in when he was about 22½ years old. He was a big-boned, thin, and anæmic looking man. Physical examination revealed nothing abnormal in the chest or elsewhere; the urine showed traces of urethritis, not quite cured. At times, especially in the urine passed in the morning and during a difficult stool, a fairly large number of spermatozoa were detected.

The treatment was purely local. In the course of three months Mr. G. felt quite well, and obtained a post in Italy. After having remained perfectly well for two years, he got another attack of gonorrhœa. Seminal emissions again became frequent, and difficulty of breathing returned, especially at night, just before falling to sleep. In 1885 he returned to Switzerland and placed himself again under my care. At present he is married and enjoys perfect health.

CASE XV.—*Sexual Anomalies. Phrenic Asthma.*

In the middle of July, 1885, I was called to see Mr. Th., ætat. 35, painter, who was suffering severely from some lung trouble. I found him in bed, thin and anæmic. There was no fever, but he complained of great difficulty in breathing, and gave the following *history*: About three months ago, whilst at his work, he felt a peculiar constriction in the neighbourhood of diaphragm. He could no longer draw his breath properly, and felt as if his chest were in a screw-press. At the same time he had intense pain in the region of the stomach. It lasted half an hour, only to return, however, on the following day. This happened almost every day, and even several times on the same day. The duration of an attack was sometimes two or three hours, and the pain was intense. Latterly he suffered so much that he was scarcely able to follow his occupation. His former medical attendant told him that it was "spasm of the midriff," and I quite agreed with the diagnosis. Mr. Th.'s family history was as follows: His father was a robust and strong man; his mother, on the other hand, was nervous, and suffered greatly from headache, as also his only sister. As a boy he was vigorous and healthy; had a distaste for beer and wine, which always gave him a headache. When 15 he became apprenticed, and in the course of a month he lost flesh considerably, and suffered alternately from constipation and diarrhœa. Constant borborygmi and frequent nocturnal emissions.

When 18 he went to America, where he was constantly working in the open air, and felt relatively better than during his apprenticeship.

When 19, after prolonged constipation, he had severe headache, which lasted from morning to night, disappearing with vomiting. Henceforth, these attacks of megrim constantly recurred, obliging him to remain in bed, and even on the next day he was scarcely fit for work, feeling quite exhausted and stupid. He especially noticed that sexual intercourse produced megrim the next day.

When 25 he returned to Switzerland, where he had hoped to get rid of his headache, which in the meantime had become nigh unbearable. However, his hopes were doomed to disappointment. When 27 he was compelled, from external circumstances, to marry. Although he was very moderate in sexual intercourse, he always felt unwell after it. Ejaculation occurred prematurely, and sexual desire was very slight. After some time, owing to his losing flesh and the frequency of headache, he was advised to give up work. A two years' rest, however, brought no improvement, and Mr. Th. consequently resumed his occupation. When 30 he suffered severely from sciatica on the left side, which lasted some nine months. Morphine had to be frequently administered hypodermically. Headache had somewhat decreased during that time, but returned as severe as ever, accompanied by frequent giddiness. He remembered one night to have awaked with a dreadful feeling of giddiness, headache, and oppression on the chest. When 32 he suffered for a time from a peculiar form of mental aberration whilst executing some work, which was so great a strain on his mind that for a week he was quite unable to sleep. As a result he became affected with ideas of exaltation, which lasted some 14 days. He thought that he was called upon to reform his trade by delivering addresses and by writing upon the subject, and that he was endowed with great ability and strength. A few days after he discovered he was unfitted for his supposed vocation, and thought he was despised on all sides; took gloomy views of everything, and despaired of the future. During the day he was restless, never sitting still; at night he either did not sleep or, which was worse, suffered from nightmare. His medical attendant wished to send him to an asylum. Suddenly he quite recovered mentally. He felt as if a great change had come over him. For nearly a year after he was much better, and no longer troubled with headache. Then by degrees obstinate constipation reappeared, accompanied by headache and the above-mentioned spasm of the diaphragm. He was much depressed in spirits, and the amount of work he was able to do was much less, which greatly distressed him, as he had now four children to support.

Examination of the lungs revealed nothing abnormal—no catarrh and no emphysema, and the other organs of the body were apparently healthy. The urine was free from albumen and sugar; on several occasions, however, semen could be easily detected.

Local treatment of the affection brought about complete cure of the asthma and other nerve symptoms.

This case is particularly interesting, as it shows that the asthma appeared as a neurasthenic symptom alternating with headache and giddiness, sciatica and mental disturbance, and, further, that all these troubles disappeared on local treatment being systematically carried out.

CASE XVI.—*Nasal Asthma Combined with Sexual Asthma.*

Mr. F., ætat. 36, merchant, gave the following history: Up to his 16th year he enjoyed excellent health. When 14 he began to masturbate, and continued this vicious habit for several years (five to six times a day). When 17 he had a severe cold, which lasted some weeks.

Up to that time he had not noticed any evil results from masturbation. Now his health began to give way, he became pale, anæmic, monosyllabic, and morose, and tried to overcome his bad habit. He took no interest in female society, and up to 22 had only had sexual intercourse four times. The first two occasions virile power was quite normal, on the last it was distinctly weakened. When 24 he obtained the mastery to some extent over his passion, and thereupon nocturnal emissions began to occur. When 25 he had a severe attack of gonorrhœa, accompanied by swelled testicle, which laid him up for a month. When 29 he had the first attack of asthma, which at first happened monthly, then every three weeks, later on every fortnight, and at last every week, and at times more frequently still. Cold beer, wine, &c., in fact, any exposure to cold, had a particularly pernicious influence over these attacks. They, in turn, were usually followed by oft-recurring seminal emissions, which produced great nervousness.

Compressed air and hydropathic treatment in Schönegg brought about some alleviation, which, however, did not last long.

When 32, Mr. F. was under the care of Dr. Hack of Freiberg, who cauterised the thickened nasal mucosa. A marked improvement followed, which lasted some months, and no asthma occurred. His general health also greatly improved. Nevertheless, towards evening he suffered somewhat from oppression on the chest, and had again recourse to the pneumatic apparatus. Seminal emissions likewise became less frequent. In the course of time a relapse occurred. Nocturnal emissions frequently occurred, even after sexual connection on the preceding night. Sleep was disturbed, and towards morning he would have a severe attack of asthma. He now consulted Dr. Müller, who found marked pulmonary emphysema, depression of the diaphragm and complete obliteration of the cardiac dulness. Auscultation revealed everywhere purring and cooing rhonchi. As regards the sexual functions, in addition to very defective virile power and frequent nocturnal emissions, slight spermatorrhœa was present.

His general health was at the time rather bad, besides neurasthenia he was greatly depressed.

Dr. H. Müller treated the sexual troubles locally.

In quite a short time marked improvement in the general health took place. Asthma did not recur, and Mr. F. married.

A year after Dr. H. Müller heard from the patient that he was quite well.

Causes of Sexual Asthma.

If we once more pass in review the various histories of these cases, which have told us the causes of the attacks of asthma, we find that in eleven cases occurring in males spermatorrhœa was present in nine. On two occasions I did not make a thorough microscopic examination of the urine, although no doubt from the condition of the genital system I would have obtained corresponding results. Spermatorrhœa was accompanied by some functional anomaly, the most frequent being nocturnal emissions and impotence, or at any rate great loss of virile power. Twice I observed temporary aspermatismus.

In the five cases occurring in women, uterine fibroid occurred once; vaginal and cervical catarrh and hyperæsthesia of the ostium vaginæ, due to masturbation, once; leucorrhœa once, cause unknown, as no vaginal examination took place; enlargement, induration and catarrh of the uterus after the menopause, once; and chronic metritis once.

Case XVI. shows that there may be several causes at work in such patients in the production of asthma; in this patient two chief causes were present.

Constitution and nervous taint. Out of eleven men, seven were very strong and well developed, and four rather slim and delicate looking. In two cases only was there an inherited taint of nervousness on the maternal side.

With almost all the males, in addition to asthma, there were other nerve symptoms present; in fact, that condition which we understand by the phrase sexual neurasthenia.

This is almost without exception the result of sexual abuse in its various forms. As regards the women, a hereditary nervous taint could only be ascertained in two. On the other hand, all suffered, in a more or less pronounced form, from hysteria and other nerve symptoms, which, like the asthma, depended upon some uterine affection, and therefore belong to the same category.

Condition of the lungs. In ten there was more or less severe emphysema, which, as a rule, did not give rise to any complaint. They could walk, go up hill, and take part in the manœuvres. A few only suffered from frequent catarrh of the respiratory tract.

Manifestation of the asthmatic attacks. It is well known that congestion plays an important part in asthma, for not only in the idiopathic form but also in the rest it is frequently ushered in by nasal and bronchial catarrh. There are individuals in whom any slight catarrhal irritation is accompanied by asthma (Bronchial asthma—Biermer, Berlin clinical transactions). What the exact connection between catarrhal hyperæmia and bronchial spasm is we cannot say. We may, *a priori*, suppose that either bronchial congestion produces bronchial spasm, a causal relation thus subsisting between the two, or that both are the result of a disturbance of the nerve paths, in other words result of reflex action.

On the other hand, cases of bronchial asthma are met with—and Tronsseau drew attention to these—where no symptoms of catarrh are present at the outset, but which terminate with such, so that it would seem that bronchial hyperæmia may be a sequela of asthma (Biermer).

The congestive element likewise plays a part in sexual asthma, for some cases commence with nasal and bronchial catarrh. On the whole this is not so frequent.

In one case only I observed that sexual asthma was brought on sometimes by heavy drinking.

In a few, the attacks were, so to say, spontaneous, *i.e.*, no exciting cause could be ascertained.

The majority, however, were brought on by mere sexual excitement, or by the simple act of coitus, or even by nocturnal emissions.

In a few cases the patient was convinced that there was a connection between the sexual malady and asthma; in the rest, I suspected that it might be a cause of the attacks.

In some the sexual act was so regularly followed by asthmatic attacks that the relation was at once patent.

Diagnosis. The chief point is that we should know and always bear in mind that disturbance of the generative system is one of the chief exciting causes of asthma in males as well as in females.

We must thoroughly inquire into the history and condition of the sexual functions. We shall then learn whether the patient has suffered from congenital weakness of the uro-genital system (wetting the bed), whether he has either during youth or later on been addicted to sexual abuse of any form, whether he has ever had any venereal trouble (gonorrhœa, &c.), whether nocturnal seminal emissions are morbidly frequent, or, lastly, whether any anomaly of the sexual function occurs. Examination of the urine—frequently made—and endoscopy, if necessary, should inform us as to the present condition of the uro-genital system, especially whether chronic urethritis or spermatorrhœa exists.

Similarly, in the case of women, we must inquire into the history of the sexual functions, the amount and duration of the menses, the character of the molimina, the presence of fluor albus or of lumbar symptoms (back-ache, &c.). If the history indicates its necessity, a vaginal examination should be resorted to.

Having then carefully informed ourselves upon these points, we find, for instance, that in an asthmatic patient, after long continued masturbation during youth or after excessive sexual indulgence, especially in coitus imperfectus, or with partial impotence, by microscopic examination of the urine, spermatorrhœa exists and other nerve symptoms are present, then, by careful exclusion of other causes, the diagnosis of sexual asthma may be made. Our diagnosis is likely to be more certain if we find that any sexual event precedes the attack of asthma.

Of course we must not forget that even in the same patient other exciting causes may be present as is seen in Case XVI.

We can only be quite certain of our diagnosis when, along with the sexual affection, asthma also ceases.

Prognosis wholly depends upon the cause.

As a rule, however, we can say that it is favourable in sexual asthma, as a fair number in the course of time recover completely. I have observed severe cases where for 13 years no attack of asthma has recurred.

The *treatment* of sexual asthma is naturally that of the primary cause and will vary accordingly.

In women this, of course, belongs to the province of the gynæcologist. I should, however, like to mention that the medical attendant should not overlook, from false prudery, the evil consequences of onanism and coitus imperfectus. In men great importance must be attached to the latter point. For, as a rule, the patient is ignorant of the pernicious results of this practice, for it is but true that, in persons of nervous disposition, neurasthenia sexualis is thus brought on and kept up. In Case VIII. I found that the seminal emissions and asthma were not benefited in the slightest degree as long as coitus reservatus was continued. After this was stopped, they both ceased under the administration of cold water enemata before retiring.

The urethritis posterior, on which sexual asthma depends—be it specific in nature or otherwise—as well as spermatorrhœa, impotence, or temporary aspermatismus, must as a rule be treated locally. General treatment is, of course, of material value, but as a rule is not sufficient to cure the affection.

It is not within the limits of this paper to consider the treatment of chronic affections of the male generative organs that may be the cause of sexual asthma.

I shall here only mention that the treatment usually is somewhat difficult and troublesome, and requires great perseverance, both on the part of the doctor and patient, in order to arrive at a happy result.

TRAUMATIC NEUROSES.

BY

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TRAUMATIC NEUROSES.

GENTLEMEN,—The subject I have chosen for this address* will, I trust, have no little interest for you. For what I am going to speak about is certain morbid conditions in regard to which the physician at the present day, and in consequence of modern legislation, is frequently obliged to give a decisive opinion, and an opinion the formation and precise expression of which are often attended with no small difficulty. I believe, however, that these difficulties exist, not merely in the nature of the things themselves, but also, and perhaps even more, in the circumstance that in our appreciation of the morbid conditions in question we are not uncommonly too one-sided in our views, and leave out of account considerations of great importance.

Although the cases I am about to speak of are of very common occurrence and, as you can understand, must necessarily have been known to the older physicians, yet the exact study of them has gone on only for the last twenty or thirty years. At all events, it was their frequent occurrence after collisions and suchlike accidents that first drew the attention of railway companies' surgeons to them, especially as practical questions of damages were first raised in the case of railway servants. It is well-known that a particular clinical picture has been formed by English surgeons especially (Erichsen and others), which even in Germany we frequently call by its English name of "railway spine," the origin of which is commonly said to be the severe shock to the spinal cord which occurs in a railway accident.

This name "railway spine," however, was plainly not very happily chosen. On the one hand, it must be at once noted that there evidently does not exist a certain kind of injury peculiar to railway accidents, and experience shows that precisely the same symptoms frequently result from other accidents of every description. On the other hand, a more careful consideration and analysis of the symptoms brought out that it was quite impossible that they could be dependent merely on a disturbance of the functions of the spinal cord. Numerous phenomena of undoubtedly cerebral character pointed distinctly to concomitant affection of the brain; even symptoms which had previously passed as spinal came more and more to be looked upon as of cerebral origin. For these reasons American neurologists, Walton and others, proposed instead of "railway spine" the name "railway brain" as more suitable. This was certainly an important forward step for the proper pathological understanding of these affections, especially as the observers drew attention to the affinity which these cases of "railway brain" had with neurasthenia and hysteria. It may be even asserted that it was the exact systematic study of the two last-named diseases which first made it possible at all to arrive at a proper understanding of the nature of the "traumatic neuroses."

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* An Address delivered to the Nürnberg Medical Society, on March 1st, 1883.

This expression, "traumatic neuroses," appears to me at present at any rate to be the best we have. It implies first of all nervous affections, the origin of which must be immediately referred to some injury or other. Further, there is implied in the word "neuroses" the supposition that the nervous symptoms in question are not dependent on coarse injuries of any part of the nervous system. Traumatic paralysis through crushed or torn nerves, lesions of the cord or brain from fractures or dislocations of the vertebræ or fractures of the skull, traumatic hæmorrhages, secondary inflammatory conditions—all of common occurrence, and important as they are—do not belong to the traumatic neuroses. But we must note—and this is the first point of importance—that after certain injuries attended by no coarse lesion of any part of the nervous system, peculiar and serious nervous disturbances may be produced, which may last a long time, and are not infrequently incurable; and, further, that we cannot understand these if we seek their causes in any one of the above-mentioned coarse anatomical changes.

Before we go into the question as to how these conditions may be explained, it is proper to treat of their symptoms a little more fully. We shall do this first from the purely clinical and empirical side, and see what practical experience has to teach us.

As advantageous in a general survey, it appears to me advisable to distinguish two chief groups of the traumatic neuroses, and to describe these separately. In one set of cases, occurring generally after some local injury, there are merely local nervous disturbances, *e.g.*, in one leg, in one arm, or such like. We may name these cases "local" traumatic neuroses. In other patients we have, mostly as a result of some severe shake to the whole body, a much more complicated set of symptoms, and among them, in particular, certain general nervous phenomena appear in the foreground. This group we call "general" traumatic neuroses. Let us first examine more closely the latter.

I shall suppose a particular case, in order to bring the features of the affection as clearly as possible before your eyes. A workman—let us say a carpenter—previously in perfectly good health and strength, falls from a scaffolding a distance of twelve or fifteen feet. In consequence of the shock he is rendered unconscious, or at least very much stunned, and his fellow-workmen have to carry him home. After some hours he comes to himself, but feels so languid that he "can't move a muscle." The medical man who is called finds no evidence of severe injury—perhaps only a fractured rib or even only some skin-wounds with ecchymoses. The patient recovers but very slowly, and can only leave his bed after the lapse of some weeks. The relatively trifling bodily injuries which he received at first have long ago healed. Nevertheless he feels very weak, complains of various pains, and says that he is as yet quite unfit for work. His medical attendant thinks there may be some internal injury or its effects, and repeatedly and carefully examines the limbs, spine, lungs, &c., but can "find absolutely nothing abnormal in any of the organs." The authorities wish a medical report in regard to his condition. A second doctor is called in, and he also can "find nothing," so the suspicion readily gets up that the patient is shamming, and intentionally exaggerating his complaints, in order to avoid working for some time longer.

And yet, gentlemen, in cases of this kind there is generally a very great deal to be observed. We have only to know what the proper symptoms are, and to seek after them in particular. I do not mean by the proper symptoms dislocations or fractures, displacements of the vertebræ or pleural exudations, but rather certain peculiar nervous disturbances which meet us in all these cases in so constant a fashion as to give us in their totality a thoroughly characteristic set of symptoms, forming the clinical picture of general traumatic neurosis.

We must have regard first of all to the psychical condition of the patients. I cannot refrain here from remarking that, unfortunately, in the case of a large number of patients the requisite attention is not paid to the mental symptoms. And yet there are a number of morbid conditions which the physician will never rightly comprehend, without paying attention to these symptoms. We must accustom ourselves to take account even of the more trifling psychical alterations. These are undoubtedly much commoner, and therefore practically much more important, than the more severe, just as coughs and catarrhs are commoner than pneumonia or tuberculosis. The more severe kinds of mental disturbance, indeed, are quite recognisable, even by the laity. Of course the practitioner in private practice often meets with great difficulties in the way of rightly judging of the mental condition, which he would not have to contend with in a hospital or similar institution.

The mental disturbance in traumatic neurosis exhibits chiefly the features of melancholia, mostly of the hypochondriacal type. Many of the patients are fully conscious of the change in themselves. They tell us that previously they were of a cheerful and contented disposition, but that now they take no pleasure in anything. They sit silent in the midst of their families, and keep out of the way of the company of old friends; nothing apparently interests them. Their thoughts are continually playing about the incidents of the accident and its results, and the only occasions on which they talk freely are when they are speaking of these. At such times, however, we can note how thoroughly they are convinced of the serious consequences which the accident has had for them, and how deeply they are persuaded that they will never enjoy health again, never be able to attain to their old strength and energy. These dismal convictions often bring on a state of excitement, and the patients in the course of conversation will begin to weep. In such conditions we may even have hallucinations and delirium coming on, although these are very much rarer than the above-mentioned states of slight melancholia. With the latter is closely associated a peculiar weakness of will and lack of energy, with anxious fears of various kinds. The patients cannot brace themselves to any kind of regular employment. Everything irritates and distresses them. They avoid meeting other people, and are alarmed at any loud noise or slight commotion, or such like. Their agitation rises to a high pitch on the occasion of every fresh medical examination or inquiry. This is also the case when their recollections of the accident become unusually lively; for example, when they revisit the place where it occurred.

The patients frequently complain that their memory is weak, and that they are incapable of fixing their mind steadily on any subject. For example, they are unable to read for any length of time; after a few minutes their thoughts get confused, and they cannot understand what they have read. It is the same with every other kind of mental activity. They can no longer calculate figures as they used to do, or follow a story or a sermon. In many instances these symptoms, especially when they are present only to a slight extent, seem to me to depend, properly speaking, on a disturbance of the intelligence. It is merely that the patients are taken up almost exclusively with themselves and their troubles, and that they have no attention to spare for anything outside, nothing else making a deep or lasting impression on them. But in severe cases, as I have seen again and again, distinct mental weakness comes on at last, with failure of memory and incapacity for any continuous mental exertion.

The sleeplessness, also, of which most of them complain must be for the most part referred to the persistent mental unrest which I have described. The constant anxiety hardly ever permits of the quiet state of mind which is the first condition of falling asleep, or not infrequently the thoughts of the waking state are carried on into dreams, which then associate themselves more or less closely with the events of the accident. A sleep of this kind, of course, is restless and unrefreshing.

All these mental symptoms are so characteristic of general traumatic neurosis that there is scarcely a single case in which they are quite absent. Their occurrence was not altogether unknown to the older observers, but their importance and profound significance for the comprehension of this morbid condition, as a whole, has only recently been shown, in particular by Moeli and Oppenheim. They vary very much in intensity, being present sometimes in a slighter, sometimes in a severer, form, and may occasionally constitute the only evidence of the affection. We may then, in fact, speak of a pure traumatic psychosis.

Next to the psychical symptoms come a second group of disturbances, also of uncommonly frequent occurrence, and therefore of the greatest diagnostic and practical importance—the sensory abnormalities, especially the anæsthesiae. The merit of having drawn attention to the occurrence of this class of symptoms belongs among the German physicians chiefly to Thomsen and Oppenheim. Their practical importance consists in this, that their objective existence can generally be easily established, and statements regarding them formulated, making them very valuable as a basis for a professional opinion and report.

The examination of the sensory functions in every case of traumatic neurosis must extend to all the special senses. The patients' own statements do not generally assist us much. They certainly sometimes remark, of their own accord, that their eyes get dim or that all their food has an insipid taste. They also complain of too great susceptibility to all the more violent kinds of sense-impressions—strong lights, loud noises, &c. But the actual extent of the sensory lesions can only be determined by a careful objective examination. If certain parts of the body, for example, one side of the thorax or a portion of the spinal column, have been specially affected by the injury there is, as a rule, at this part a remarkable tenderness on deep pressure. The skin here, also, is sometimes hyperæsthetic, and a slight prick with a needle is felt as acutely painful. Not infrequently, however, the skin over the part in question is anæsthetic, and pricking deeply with the needle produces no sensation at all, or at least none that is painful. But, in general, the cases where the chief disturbances are found just at the seat of the injury belong more to the local traumatic neuroses of which I shall speak later. Yet we must particularly note that profound disturbances of sensibility may be present in parts of the skin far removed from the seat of injury, and in cases where there has been a general shock to the whole body such disturbances may be found in a number of different places. The distribution of these anomalies follows no rule. Sometimes we find large anæsthetic patches on the breast, on the back, in the face, or on the scalp, sometimes anæsthesia of one or more extremities in their whole extent or merely in certain portions of them, surrounding, it may be, the extremity as a zone-like band. These areas never coincide with the distribution of particular nerves, nor are they marked off in the same way as in the case of lesions of the brain or cord. Like Oppenheim, I have only occasionally observed genuine hemi-anæsthesia, and only in cases which had otherwise more of the character of local traumatic neurosis or of traumatic hysteria (see below).

If the anæsthesia is very marked in particular parts of the skin all the forms of sensation are affected. But partial paralyses also sometimes occur, there being special affection in some cases for touch, in others for heat, and in others for pain. The last appears to me the commonest. The patients feel slight cutaneous irritation fairly well, but over large portions or even over almost the whole surface of the body exhibit an astonishing indifference to very deep pricking with needles or very strong faradic currents.

The anæsthetic areas are marked off, as we have said, according to no definite rule. Sometimes an anæsthetic area borders upon a particularly sensitive portion of the skin, while in other cases they are more ill-defined and vary at different times. The occurrence of the latter peculiarity must be borne in mind, and we must not, without close inquiry, come to the conclusion that there is simulation in such cases.

The sensory disturbances are by no means limited to cutaneous sensations, but are present even more distinctly in the special sensory surfaces. Here, also, we must seek for them, otherwise they may only too easily remain unnoticed. If a careful objective examination, however, is made, the most surprising symptoms come to light. In the sense of sight there may be simple diminution of acuteness of vision, or the eyes may be easily wearied, or there may be weakness of the colour-sense, or narrowing of the field of vision. In hearing, we often find considerable diminution of the auditory acuteness on both sides, or more on one side than on the other, while examination with the speculum fails to reveal the slightest evidence of organic disease. Examination of smell, and particularly of taste, should never be omitted, as it is often in these sensory areas that the greatest disturbances show themselves. Taste may be wholly abolished or retained in respect of only some qualities. Many patients, for example, can feel the taste of salt or sugar and not of quinine.

All these sensory lesions are so common in traumatic neurosis, and present in so characteristic a way, that they are of the utmost value in the diagnosis and proper estimation of cases of the affection.

Among subjective pains we have already mentioned the hyperæsthesia at the seat of injury. Pains in the back and headaches also are common, though not, for the most part, specially severe. In many cases the remarkable tenderness of the head to percussion is characteristic.

Motor symptoms are present in almost all the more developed cases. In neurotic cases, without special local manifestations, the commonest symptom is general muscular weakness, or, to express it more exactly, general weakness of voluntary innervation. With good muscular development and an appearance of strength they are unable to grasp firmly with the hand or to lift any heavy weight, and exertion exhausts them easily. Their walk is generally slow and laboured, but varies very much when local disturbances are added to the general weakness. Very often when the original injury has affected the haunch or back, these parts continue to be painful, and the pain is increased by any movement or shaking of the body. Patients suffering in this way, in going about, avoid all the more pronounced flexions of the spine, keep the back somewhat bent, but at the same time as rigid as possible, and endeavour to support the haunch with the hand. A good while ago I had under observation an officer who was affected with severe traumatic neurosis in consequence of a fall from his horse. He was so afraid of any great movement of the spinal column, especially of the slightest turning of the head, that he could not directly turn round to look at any object near him, but with timid steps described the arc of a great circle through the room.

Besides the general muscular weakness, there are very frequently certain symptoms indicating motor irritation. These are chiefly tremors and rigidity and stiffness of the muscles. We shall devote more attention to these in describing the local traumatic neuroses, but even in the general form they are sometimes very marked in certain limbs. We have trembling of the arms, especially when the patients stretch them out unsupported, or still more evidently when from this position they bring the index fingers near one another. Any mental emotion, any increased attention to the affected limb, increases the tremor, while, on the other hand, it may temporarily disappear if the thoughts of the patient are led away from it. The muscular rigidity in the back, legs, and elsewhere, is brought out by passive movements. It is not either a direct or reflex contracture, but probably originates, in most cases, from an unconscious voluntary innervation (see below).

The examination of the reflexes often reveals noteworthy conditions. In anæsthetic or analgesic parts, pricking with a needle produces no skin reflex whatever, or only a very weak one. On the other hand, extremely active cutaneous reflexes are elicited from hyperæsthetic areas in the skin. The plantar reflexes especially are very often increased, though in other cases they may be quite absent. The superficial reflexes over the abdomen also vary very much, while the cremaster-reflex is almost always within its normal limits. The tendon reflexes are, it would seem, generally increased. It is only in the cases where there is great muscular straining in the legs when an examination is made that it can be difficult to elicit the tendon reflexes. I have never seen actual absence of the knee-jerk. In those patients in whom the knee-jerk is very active it is not uncommon to observe after the proper reflex in the quadriceps two or three pretty strong jerks of the whole limb. This symptom, which is observed also in nervous persons, doubtless depends on unconscious voluntary movement. It is obtained if one merely makes a feint of bringing down the stroke with the percussion hammer while not even touching the ligamentum patellæ.

Local trophic symptoms, especially muscular atrophies, are sometimes seen in the local form of the neurosis. In the general form we see in many cases a distinct alteration for the worse in the whole nutrition; this probably results, for the most part, from the insufficiency in the amount of food consequent on the want of appetite, from the disturbed character of the sleep, and from other such like causes. The fact that has been repeatedly observed, that in some bad cases of traumatic neurosis the hair very quickly turns grey or falls out largely, must be due to a more directly nervous cause. It is natural that we should associate such disturbances with the well-known facts in regard to the influence of mental emotion, especially of those of a depressing kind, on the nutrition of the hair.

Organic changes in the internal organs are, as might be understood, absent in pure traumatic neuroses. Functional disturbances, however, are frequently present, especially in the organs on whose activity mental states have most influence. For example, many patients complain particularly of want of appetite, oppressive feelings about the stomach, nausea—in short, of the symptoms of nervous dyspepsia. If, in consequence, an insufficient amount of food is taken, then, in addition to the general emaciation previously referred to, there is, of course, irregularity in the action of the bowels. The action of the heart, as in almost all nervous persons, is generally quickened and very easily affected by external circumstances. Any mental emotion, and especially any medical examination, is apt to bring on great palpitation and acceleration of the pulse. Pronounced derangement of the bladder-functions is in purely neurotic conditions absent; and the inability to empty the bladder completely, which many patients complain of, is, as a rule, only one manifestation of the general want of muscular energy. The lowered condition of sexual desire which is often present may also be associated with the mental depression. Where there are sexual or vesical disturbances of a graver kind they indicate, probably, coarse lesion of the nervous system, and do not come under consideration in traumatic neurosis proper.

After this endeavour to bring before you the clinical details of so well-defined a disease, we shall now pass to the question of what we are to think of the nature and origin of the condition. The answer is not very easy, and neurologists differ very much from one another in their views. If we glance over the whole complex of symptoms we notice an undeniable similarity to a great number of cases of what is called general neurasthenia. In both conditions there is a large number of subjective complaints, and abundant proof that both the mental and bodily activity are interfered with, and yet in neither is there anything present pointing to a definite localised anatomical lesion. It has been, therefore, proposed to call traumatic neurosis simply "traumatic neurasthenia." But, on the other hand, in traumatic neurosis there is, as a rule, a whole set of symptoms which are not generally met with in ordinary neurasthenia, namely, the above-described sensory disturbances. These recall distinctly the analogous phenomena which are so common in hysteria, and have given rise to the conception of traumatic neurosis as a form of hysteria—traumatic hysteria,—a view which is represented especially by Charcot. German neurologists, on the other hand, especially Oppenheim and Thomsen, while they recognise to the full the close relationship between traumatic neurosis and these other two diseases, have claimed for the former a position of its own. They point to the ætiological factor—the distinct bodily injury—and also to certain peculiarities in the further course of traumatic neurosis as distinguishing it from hysteria, especially the fact that it is frequently incurable.

It appears to me that these differences are largely disputes about words. For neurasthenia and hysteria are notions of so changeable a character that we are unable to set up definite and generally accepted criteria for the precise recognition of each case of disease. Further, also, I believe that we cannot put all cases of traumatic neurosis on the same level, and that we must employ varying considerations in judging of the individual cases.

In one section of the cases all the symptoms, it seems to me, are of purely psychical origin. Let us first realise closely the circumstances in which the disease originates. Undoubtedly, along with the bodily accident on each occasion there is associated violent mental emotion—"mental traumatism." And, apart from any concussion of the brain, which may confuse the consciousness for a longer or shorter time, the accident in itself is always the cause of great fright. A multitude of anxieties presses in upon the thoughts of the injured person. What is to become of me now? Can I ever again be well and fit for work? Who is to provide for my wife and children? These, and thoughts like these, the more active in proportion to the suddenness with which they have acquired meaning, occupy the patient's attention continually. The bodily injuries which, though not severe in themselves, do generally exist, and the immediate results of the great shock to the whole system, seriously affect his capacity for doing anything, and the doubts whether it will ever be better with him are started afresh. The question arises, Who is to recompense me for these injuries, which I have suffered in the service of other people? Then come the negotiations and examinations in connection with accident insurance. One requires to have seen for one's self how these people have been put off time after time, and how repeated examinations have to be made and new certificates drawn out. It is then possible to understand the hurtful influence which all this period of doubt and hope and fear, of disappointment and mistrust must exercise. It is not to be wondered at if, in order to establish their just claims, they sometimes attempt to embellish and magnify the story of their sufferings.

In this way the depression and lack of energy and irritability with which they are affected, to begin with, and which all through are characteristic of the condition, are but strengthened and confirmed. The great attention they pay to all their sensations is sufficient to develop a variety of morbid feelings which in their excited condition take a very vivid form. On the other hand, their mental state reacts on a number of their bodily functions. We thus have headaches, palpitation, indigestion, profuse sweating, or great coldness of the skin, tremors, &c.—all familiar symptoms in conditions of great mental excitement. Unconscious attention also interferes with the normal motor innervation. Not from design, but from the action of "unconscious will," if one may so phrase it, the movements lose their natural simplicity and ease, and become stiff, trembling, and awkward.

But though I rate very highly all these purely mental factors in accounting for the origin of traumatic neuroses, they will not explain directly the whole body of the phenomena. Even the clinical differences which mark them off from ordinary hypochondriasis and neurasthenia suggest the question whether the purely material shock has not a certain importance for the production of the symptoms. It is generally acknowledged that a sudden violent shock to the nervous system, especially to the brain, even though no coarse anatomical lesions are produced, may be the cause of very serious nervous disturbances. It scarcely admits of doubt that these disturbances, such as unconsciousness, slowing of the pulse and respiration, &c., have an organic cause of some kind or another, although of the finer changes in concussion of the brain, as it is called, we know as good as nothing. And it is quite conceivable that the morbid changes produced by sudden violent concussion in the brain, and probably also in the spinal cord, do not in all cases completely retrogress, and that there is sometimes left behind a certain material, though subtle, disturbance, the nature of which is still unknown to us. The consequences of a disturbance of this kind are naturally not the same as those which follow a coarse localised lesion, but they show themselves probably in the muscular weakness, the mental change, the diminution of sensory activity, &c., which we have detailed above. It is perfectly impossible to decide at present which of all these symptoms are organic in origin and which are psychical, *i.e.*, produced by mental ideas; and, in addition, there is the uncertainty as to how far the mental disturbance, as such, may have an organic origin, and how far in its turn it may give rise to fresh bodily disturbances.

The view of traumatic neuroses we have here taken is of practical importance in this way, that it lets us understand many cases where there are no mental elements among the causes, and others where the influence of such elements has been overcome while the symptoms continue practically unchanged. The disease occurs not only among the working classes where, naturally enough, the mental factor must play a great part, but among other ranks, for example, among officers in the army who have been thrown from horseback. And all observers further have noted the fact that, even after the patients have been made quite at ease in regard to their external circumstances, very often no essential improvement follows. In the case of the injured workman, if he has at last got a favourable settlement of his accident insurance claims, and has been made definitely certain of full compensation, the symptoms do not, as a rule, come to an end. He remains moody and spiritless, his morbid feelings continue to be as before, and the sensory and motor disturbances are unchanged. As a matter of fact many cases appear to be incurable. It is of the greatest practical moment to be aware that there is this very unfavourable prognosis in severe cases of general traumatic neurosis. I have often seen medical certificates in which the opinion was expressed that, with sufficient care and proper treatment, an improvement in the condition might in time be looked for. The supposed trifling character of the symptoms, and the absence of everything of a grave or critical nature among them, certainly seem in many cases to justify such a view; and yet experience almost always teaches the opposite. In severe cases, and my experience is that of others, I have only rarely seen essential improvement, and never actual recovery, and this in spite of every care and persistent electrical and hydro-therapeutic treatment. In some cases, in fact, we find the initial symptoms—more especially the indications of mental weakness—getting distinctly more marked in the course of years. This circumstance marks an essential difference from ordinary neurasthenia, in which also permanent recovery only rarely occurs, but in which temporary improvement can be often attained by the proper bodily, and more especially by suitable mental, treatment. Among cases of traumatic neurosis mental treatment is often just as ineffective as in genuine melancholia.

We require, then, if we would understand traumatic neurosis, to take account of both its possible causes. These are: (1), the psychical injury, which gives rise to the hypochondriasis, and all the nervous disturbances arising from this; and (2), the material injury so often present from which originate the subtle organic changes in the nerve substance, and the marked functional derangements which follow. Cases of the former kind are always the less serious, and are susceptible of mental treatment. In the latter the prognosis, so far as complete recovery goes, is very unfavourable. Of course both kinds of causes often co-exist, and when this is the case it may be impossible to make a strict distinction between them.

I must here mention another circumstance which is not without importance for the understanding of this subject. General traumatic neurosis may be associated in its origin with actual coarse traumatic lesions of the brain or cord. I have seen some very characteristic instances of this. Along with symptoms which could only have been caused by a coarse lesion, such as circumscribed paralysis of cranial nerves, severe vesical disturbances, &c., there were other symptoms which could have had nothing to do with ordinary organic disease, and which perfectly agreed with those of traumatic neurosis, as I have above described it. Indeed, it is perfectly intelligible that, in certain circumstances, an injury should produce not only a coarse lesion, but also the psychical commotion or the unknown finer changes of concussion which form the basis of the general neurotic symptoms.

These cases are important in a diagnostic regard, because if we were not aware of their existence we should easily meet with great difficulties and confusion in our estimate of the seat of the coarse lesion. They are important, furthermore, in respect of the question of simulation, which, for obvious reasons, plays a large part here. In cases where coarse lesions are most unquestionably present it is impossible that the patients can have any object in complaining, besides, about a number of pretended subjective troubles. As, however, the nature of these troubles, the mental depression, the feelings of pain, the lack of energy, &c., are quite the same as in pure traumatic neurosis, the complaints in the latter disease gain in objective credibility.

In agreement with most other neurologists who have seriously considered the subject, I must express my conviction that simulation in this disease is by no means so common as many physicians appear to believe. The symptoms of a well-developed case are so peculiar and characteristic that I can scarcely understand how it could be simulated. It would be astonishing, indeed, if patients in Berlin, Leipzig, Erlangen, and everywhere else, were to falsify the story of their complaints in exactly the same way. It is easy to understand that there is such a thing as simulation after bodily injury, also that it may be often very difficult to distinguish the simulated from the real morbid condition; but that this difficulty arises with anything like frequency is, in my experience, not the case. I believe it is almost always easy, especially if you have had the patient under observation for some time in hospital, to give a quite positive opinion.

I have endeavoured in the foregoing to lay before you a brief outline of the features of general traumatic neurosis, and of its meaning and importance. Let us now turn to another group of nervous disorders, also associated with injuries, to which we may give the name local traumatic neuroses. The cases I am thinking of are, to begin with, cases not of severe injury causing general shock, but of injuries that in themselves are often of very little importance, mostly bruises of some limited area, generally in one of the extremities. The patients get a fall on the knee or a blow on the arm, get a finger crushed, or some such similar accident, and as a result of the hurt, which is often to all appearance very trifling, there follow a number of distinct nervous symptoms limited, or all but limited, to the part of the body injured.

In these cases, also, we must make the distinction between those in which there is actual organic injury to the peripheral nerves and those which we should call, as before, pure neuroses. It is often very easy to draw this distinction, but sometimes we meet with difficulties. I should particularly like here to say that I suspect that after contusions of small peripheral nerve-twigs minute neuromata develop, which are not perceptible to the touch, but which give rise to acute pains, reflex muscular spasms, and other symptoms. Of course these pains and spasms could also originate from such a lesion as circumscribed thickenings of the neurilemma. I have repeatedly seen such symptoms, and others like them, especially after bruises of the fingers, proving extremely obstinate, and resisting treatment for a long time. But, as I have indicated, we cannot reckon this class of cases among the traumatic neuroses proper, seeing that coarse changes in the peripheral nerves are the causes of the symptoms; I shall not dwell upon them, therefore, any further.

Other cases that must be set aside are those which Charcot has done a good deal to make known, where after an apparently trifling injury to a joint, considerable atrophy makes its appearance in the muscles in the neighbourhood. Charcot believes this may be explained as the result of a reflex inhibition of the activity of the trophic cells in the anterior horns of the cord, an explanation which, to my mind,* can hardly be looked upon as satisfactory.

Genuine examples of the local form are those conditions where complicated nervous symptoms follow injuries, which for the most part have been of no great importance, in such a way as to exclude the presence of a lesion of any particular peripheral nerve. These are, to begin with, as we have said, mostly cases of simple contusion in one of the extremities, or of a blow, or fall, or some such hurt. There is usually no general concussion of the brain or spinal cord, but naturally enough there is often a good deal of fright, especially in the case of nervous persons or children. In children the condition is of relatively common occurrence. The pain and difficulty of movement experienced immediately after the accident are, of course, almost always considered to be the simple results of the bruise, and only after some time has passed, and the symptoms in question are still persisting, does the thought arise that there are other conditions to be reckoned with.

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* Cf. Münchener Medicinische Wochenschrift, 1888, No. 13.

One of the commonest symptoms is a hyperæsthesia of the affected extremity, which sometimes goes to an extreme degree. It is felt on passive movement, or with deep pressure, or even with the slightest touch on the skin. The limb, even in the cases where there is no great contracture (see below) is held in a peculiarly stiff and constrained position. If it is quite at rest there are, as a rule, no special sensations of pain. On every attempt at passive movement, and on the occasion of any careful examination by the medical attendant, the patient makes active efforts with the sound parts of the body for the defence of the injured part. If we attempt, nevertheless, to move the limb, loud cries of pain follow. Sometimes, as we have said, the hyperæsthesia is limited to the deeper parts, while in other cases even the skin shows uncommon tenderness. I treated for a long time a girl of 12 years of age who had suffered from a fall on the right arm, and in whom the skin over that part (without there being any definite nervous area involved) was so hyperæsthetic that not even the gentlest touch could be borne without loud complaint. The condition lasted almost a year. All treatment was without effect, but she gradually recovered completely.

Besides hyperæsthesia, anæsthesia not infrequently occurs. In particular the association of hyperæsthesia on passive movement with anæsthesia of the skin is pretty common. The latter may be present in a very high degree, and a fold of the skin may be transfixed with a needle without the patient having the slightest sensation. The anæsthesia probably always extends a good way beyond the seat of the injury, but in genuine cases of local neurosis is always limited to the affected limb. I have seen, for example, among other cases total anæsthesia of the whole arm up to the shoulder after a bruise of the elbow-joint. No doubt the anæsthesia may extend still more widely, and in particular sometimes over the whole corresponding side of the body. This, however, is the ordinary hysterical hemianæsthesia of traumatic origin (see below). Besides local anæsthesia we may have, of course, different degrees of mere blunting of the sensibility, or (rarely) partial sensory paralysis (for pain, temperature, or touch).

Motor symptoms may occur, either associated with those described above or in other cases alone. In their more trifling forms they appear as stiffness and awkwardness, which may reveal themselves in the peculiar position of the limb at rest, as mentioned previously, or more naturally in the voluntary movements. These symptoms must partly be looked upon as the result of the pain attending all movement, but chiefly as the result of the disturbance of voluntary innervation; this, instead of taking place in an easy and unforced manner, is carried out slowly and cautiously. Here also, as in the analogous symptoms in the general form of the affection, unconscious voluntary spasms play an important part in the production of the phenomena.

In severe cases the stiffness becomes rigidity and complete contracture, so that almost all motion—active or passive—becomes impossible. This is most evident in the lower extremities. The patients can, of course, neither stand nor walk, and are generally confined to bed. The affected leg is kept, as a rule, slightly flexed and rotated inwards. Every attempt at passive movement is apparently extremely painful. Sometimes the reflexes are much exaggerated; at other times, in consequence of the contracture, they are only indistinctly made out.

It is evident that these symptoms might easily produce the impression of an affection of the knee or hip-joint, and, indeed, some physicians who do not know of this common form of local traumatic neurosis have often allowed themselves to be deceived in this respect. But the diagnosis is hardly ever difficult. The general impression which the affection makes, the absence of all organic change in the joint, occasionally the association with anæsthesia, in doubtful cases, lastly, the results of examination under chloroform, make the distinction from organic joint-disease easy. The names, "neurosis of the joint," or "neuralgia of the joint," which surgeons especially often use, appear to me to be improper in this respect, that they contain the presupposition that there is an affection of the nerves of the joint. This is certainly not the case. We have to do here, as we shall see presently, with purely central disturbances.

Flaccid paralytic conditions are much less common than the contractures. They occur, it seems to me, much more frequently in the upper than in the lower extremities, and are often associated with marked cutaneous hyperæsthesia. In such cases the patients say that the arm immediately after the injury—which does not need to be a very severe one—dropped as if paralysed, and has remained immovable since. Passive mobility is often fully retained, but in some cases the movements are felt to be painful in the deeper parts, especially at the seat of the injury.

Trophic disturbances in the skin and muscles, as a rule, are absent. In some cases, where the paralyses have lasted a long time, we can observe slight wasting of the affected limb, but the electrical irritability of the muscles and nerves remains perfectly normal.

Other nervous symptoms in cases of pure local traumatic neurosis are absent. In particular, the mental alteration so characteristic of the general form is hardly ever observed. No doubt the patients show considerable anxiety under examination, and children are often wilful and unmannerly, but we see nothing of that melancholic hypochondriasis which so dominates over the whole mental life of those affected with the general form.

The question of the essential nature of local traumatic neurosis is a much simpler one than the analogous inquiry in the general form. As from the way in which the injury was received there could be usually no possibility of concussion of the central nervous system, we get rid at once of all the difficulties we met with in our discussion of the general form about the interpretation of possible delicate changes in the nervous structures. We have to do with purely functional disturbances alone, and in this we observe the complete agreement between local traumatic neurosis and hysterical affections; it is, therefore, not incorrect to call the former traumatic hysteria, that is, hysteria of traumatic origin.

In order to make this clearer I must briefly explain what I hold to be the right conception of hysteria. Fuller discussion of the subject must be reserved for another occasion.

I call those affections "hysterical" which originate through a disturbance of the normal connections and relations between the nervous processes which are concerned with the bodily functions, and which, for the most part, are situated centrally, and those processes which we must call psychical. In regard to the nature of these latter each one may think as it pleases him; but every one must allow the fundamental distinction that exists between the processes which play a part in consciousness, the psychical processes, and those which are purely concerned with the bodily innervation, and, further, that the normal course of all voluntary motion and all conscious sensation is only possible with perfectly normal associations between these two spheres. If the mutual relationships are disturbed in any way motor and sensory disturbances of the most varied kind follow. If the passage from the will to execute a movement to the motor centres (probably the well-known cortical motor centres) is interfered with we have a hysterical paralysis. On the other hand, if abnormal and morbid volitions act on the motor centres we have hysterical contractures, spasms, &c. These are examples of morbid stimuli which take origin in the sphere of voluntary action, and which may, therefore, be immediately associated with other psychical elements, such as ideas, passions, and the like.

Again, if the transmission of centripetal sensory stimuli, which, in a normal way passing to the sensory centres of the cortex, become conscious sensations, is interfered with we have hysterical anæsthesia. This anæsthesia is, however, by no means arranged according to the plan of the sensory conducting paths; hence, for example, we have complete unilateral amaurosis and not hemianopsia. If, on the other hand, the sensory stimuli pursue a normal path, but produce sensations of abnormal strength, we have hysterical hyperæsthesia. The spontaneous hysterical pains (hysterical neuralgias and the like) I look upon as excitations produced in consciousness itself, therefore, in some measure, as hallucinations of pain.

Of the exact nature of this disassociation between the psychical and the somatic spheres which forms the groundwork of hysterical symptoms we know, of course, nothing, seeing that the nature of the association itself is a perfect riddle to us. But the disturbance for the most part does not consist in a complete separation, but merely in a displacement, to use a figure of speech, a kind of luxation; on that account any hysterical disorder, as is well known, can disappear in a moment, giving place to the normal condition.

The causes of this disturbance of the union between the physical and the psychical may probably work from both sides. In very many cases they take rise in the psychical sphere. Among these come the large group of hysterical symptoms produced by suggestion, when ideas, rising with great vividness into consciousness, and referring themselves to the body proper, result in the corresponding somatic condition. All morbid symptoms originating in this way may be called "psychogenous."

In other cases, certainly of rarer occurrence, the derangement appears to originate in the somatic sphere, although I readily grant that it is difficult to say, in estimating the effect of the bodily disturbances, how far it is aided by the mental conceptions they give rise to in the first instance. This latter consideration comes in when we apply these views of the nature of hysteria to the subject of local traumatic neurosis. Whether, with a special predisposition on the part of the nervous system, a sudden violent shock to the body is of itself sufficient to loosen the union between the affected nerve channels and the mental processes, or whether the profound psychical disturbance is in every case (it frequently is) the direct and immediate agent in producing the damage, must remain for the present undetermined. This much, however, appears to me to be beyond doubt, that cases of genuine local traumatic neurosis, as we have described it, must be considered hysterical affections. The affected limb loses through the injury a portion of its normal relation to consciousness. This derangement is the result of the commotion of mind and body, both of which, as can be understood, are largely affected by the injury to the limb; the special nature of the disassociation determines the production in the individual cases of hystero-traumatic paralysis, hystero-traumatic contracture, anæsthesia, &c.

The prognosis of local traumatic neurosis, in harmony with its almost purely hysterical character, is very much more favourable than that of the general form. But there are great differences, especially in regard to the duration of the affection. According to my experience, the contractures in the lower extremities, and the peculiarities they cause in the gait, especially in children, give the best prognosis. As soon as the children are removed from unsuitable surroundings, and are taught by methodic exercise of the will the proper way of directing their voluntary action into the motor paths, the symptoms generally disappear in a very short time. All other kinds of treatment (electricity, massage, hydrotherapeutics, &c.) must be looked upon merely as mental aids to this—though no doubt often very valuable aids. In other cases, however, local traumatic neurosis proves itself to be a very obstinate trouble, and may last for months, or longer. But even in these we must not give up hopes of ultimate recovery.

With your permission I shall conclude with a brief resumé:—

1. After a severe general concussion of the central nervous system there is often produced a complicated but very characteristic set of nervous symptoms, the best name for which is "general traumatic neurosis." In its features this affection has a strong resemblance partly to neurasthenia, partly to hysteria, and partly to certain of the psychoses (melancholia and hypochondriasis). In its causation purely psychical elements predominate, but very probably we should also allow for a continued influence of the psychical shock, though this does not take the form of coarse anatomical changes. In the individual cases we must pay attention sometimes more to the one set of influences, sometimes more to the other, so that we cannot analyse all of them in the same way.

2. In certain cases where the injury acts locally—and generally, though not exclusively, in these cases it affects one of the limbs—we may have severe nervous disturbances in the affected part. These are produced, in all probability, through the influence of the mental emotions associated with the receipt of the injury, and may be looked upon as "hysterical" in their nature. Every nervous affection may be called "hysterical" (the name is certainly not a suitable one, but is in common use) which depends on a derangement of the normal connection between the psychical and the, in the narrower sense of the word, physical processes.

3. The separation between the general and the local forms of traumatic neurosis must not, of course, be pushed too far. Transitions and combinations are by no means rare. In every case we must weigh the significance of each individual symptom.

4. Cases occur of traumatic lesions of true organic character associated with traumato-neurotic symptoms, a fact that is of no small importance from a diagnostic point of view.

5. Finally, general traumatic neurosis seems sometimes to prepare the ground for the development of organic lesions, such as paralysis or tumour.

THE CAUSES AND TREATMENT OF SEVERE AND OBSTINATE CASES OF

ENURESIS NOCTURNA IN MALES.

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THE CAUSES AND TREATMENT OF SEVERE AND OBSTINATE CASES OF

ENURESIS NOCTURNA IN MALES.

WHEN Oberländer in his "current communications on the ætiology and treatment of enuresis nocturna in boys" begins with the following sentence, "the results which the present treatment of enuresis nocturna have to show are certainly of not such a nature that new and fuller views of the subject will not be welcomed," every medical man who has had to deal with obstinate cases of nocturnal incontinence will agree with him. From this standpoint I should like to contribute something to our knowledge of the causes and treatment of this affection. I emphasise the word *cause*, because this complaint, like the irritable bladder, is not a disease in itself, but only a symptom which may represent quite different pathological conditions.

Moreover, Leopold Casper states in his translation of Sir H. Thompson's work on "Diseases of the Urinary Passages," "nothing certain is known of the production and ætiology of enuresis nocturna—deep sleep, taking too much liquid, &c., can no longer claim our assent"—and yet the majority of publications deal only with the *treatment* of the affection. A number of different methods and drugs have been recommended, their influence being extolled in one case or another. Very frequently, however, the cause is not taken into consideration at all, *i.e.*, the pathological basis which lies at the bottom of the symptom of incontinence. If we are ignorant of the cause every line of treatment is haphazard in action, and its publication has but little value in the eyes of another medical man, as it affords him no guide as to how he should proceed in any other case where the incontinence may depend on a diametrically opposite cause.

It is far from my object in maintaining that henceforth in all, or even in the majority of cases, it will be possible, even after the most careful inquiry, to explain the causation of nocturnal incontinence. On the contrary, it is my purpose rather to indicate the direction in which steps should be taken to arrive at the nature of this burdensome affection which embitters the youth of so many. Treatment would be more satisfactory in its results, whereas at present Sir H. Thompson ("Diseases of the Urinary Passages," 19th edition, translated by Dr. L. Casper) states all kinds of remedies and methods of treatment have been tried with these unfortunate patients, including even the periodical use of the rod, a species of plant which is not to be recommended as a therapeutic agent. We can be convinced that punishing this form of youthful failing is of no use, for whatever moral effect may be attributed to the popular saying, "Do not spare the rod," this is quite inapposite for medical men. Frequently the relations of the child lose all patience because of the constant recurrence of this unpleasant weakness, and fancy that obstinacy or inattention on his part is the cause of it. I have seen unfortunate children cruelly treated by their nearest relations—we at any rate should never countenance such treatment.

In infancy the emunctories act without any subjective sensation, the slightest contraction of the bladder and the rectum is sufficient to void the contents, as the resistance of the sphincters is wanting. It is not until after teething that the power of retaining the urine is established. Consequently children who *after* this period pass water involuntarily with the urinary channel intact, suffer from enuresis, which represents a *persisting infantile condition.*

As the child grows up, as a rule about the time of puberty, the affection disappears spontaneously, and therefore *at a period* when the genital system reaches its complete development.

Trousseau and Bretonneau, with whom Ultzmann agrees, suppose some nervous derangement, a want of proportion between the innervation of the detrusor and that of the sphincter, which is lacking in power. During the hours of waking the compressor urethræ (sphincter vesicæ) is sufficiently stimulated to contraction by the exercise of the will, but at night during sleep a certain amount of insensibility overcomes the patient and reflex contraction fails.

In a large number of cases this view is undoubtedly correct, for a considerable percentage get well spontaneously with the advent of puberty, others become normal through treatment by electricity, and Trousseau mentions cases where a single application effected a complete cure.

We have incidentally touched upon the various causes of enuresis, which we shall now consider more fully.

In a number of cases we are compelled to assume that *congenital weakness of the posterior portion of the urethra lies at the bottom of the enuresis.*

Oberländer shares the same view: "It is well known," he says, "that the sphincter and detrusor powers of the bladder vary greatly in individuals. This variability bears no relation whatever either to the muscular power and general health, or to a more or less powerfully developed nervous system. There are just as many little weak men with powerful bladders as strong men with weak ones." According to Oberländer there is no doubt that congenital weakness of the bladder and of the posterior portion of the urethra is sufficient in itself to account for the origin as well as the persistence of this affection. In his experience men with powerful uro-genital musculature are less liable to severe attacks of vesical catarrh or posterior urethritis than those in whom the reverse obtains.

As further proof of this congenital muscular weakness I should like to mention that those who have suffered from enuresis when young, show traces of this weakness after sexual development. From the outset there is as a rule less sexual desire, and their generative organs are unable to bear as much strain as those of other men. If they indulge in, relatively speaking, slight excesses, for instance, moderate masturbation during youth or coitus incompletus when adults, consequences out of all proportion may appear, *e.g.*, exhausting nocturnal emissions, spermatorrhœa, irritable bladder, sexual neurasthenia, &c.

From my experience in this class of diseases I inquire, in every case where the sexual disturbance is out of all proportion to the exciting cause, whether the patient ever when young suffered from nocturnal incontinence, and thus at once obtain an index of the congenital strength and energy of the affected organs. I was surprised when looking up the literature of the subject to find that Lallemand held similar views. In his book on "Involuntary Seminal Emissions," vol. ii., in the chapter on "Urinary Troubles in Childhood," he says, "I have noticed all the patients who have suffered from nocturnal seminal emissions have been subject to incontinence of urine, which has lasted at least up to seven or eight years of age, and in several cases up to puberty. Even then such patients for the rest of their life are frequently obliged to empty the bladder, and always have difficulty in retaining water when the need of micturition is pressing."

Further on this author alludes to the spontaneous cure of enuresis in spite of all treatment at the period of puberty. "This close relationship," says Lallemand, "is sufficient to show that *congenital* incontinence of urine augurs ill for virility, and facts leave no room for doubt on the subject. It is therefore very important to question patients upon this point who are suffering from involuntary seminal emissions. They never attach enough importance to what has taken place during childhood; however, the practitioner may derive most valuable information from it."

In conclusion, I may quote from my work on "Irritable Bladder" the following passage which bears upon this very point: "It is not rare for *congenital weakness* of the uro-genital tract, which is manifested in childhood by wetting the bed, to be the foundation of irritability of the bladder. Such patients often suffer in later years from frequent micturition brought on by relatively insignificant indiscretion, *e.g.*, slight venereal excess (coitus reservatus, &c.), or over-indulgence in pleasures of the table (drinking, smoking, &c.)."

Other writers view the ætiology of enuresis from a diametrically opposite standpoint. They assume a reflex origin. Magenruder (*cf.* Surgical Reports, 1887) maintains that nocturnal incontinence in boys over eighteen months old is due to phimosis, or adhesion between the glans and prepuce. In proof of this he cites a number of cases where surgical measures resulted in a complete cure.

Enuresis may also occur in children suffering from epilepsy, night terrors, or other disorders of the central nervous system. It is also seen in chronic nephritis, pyelitis, stone in the kidney and in the bladder. Again, the character of the urine may be a cause, *e.g.*, uratic and phosphatic urine—the so-called scalding urine; in such cases it is assumed that hyperæsthesia of the neck of the bladder or of the whole vesical mucosa is present. I myself have published notes of a case in my article on Phosphaturia (v. Volkmann's Collection, No. 336).

Lastly, incontinence of urine is often one of the first symptoms of diabetes mellitus.

We seldom observe it as a reflex affection of the alimentary canal, *e.g.*, from the presence of worms. Another class includes such children who are ill-nourished and strumous, or sluggish and dull children, whose mental calibre is generally below the average. At times children who are physically weak, but mentally active, suffer from this affection. Sir H. Thompson says it is well known that a child of active and excitable temperament often shows during sleep more muscular movement than adults or children of quiet disposition. This may become so marked as to approach somnambulism, and it is in connection with such conditions that the bladder is often voided involuntarily.

There are, on the other hand, children who enjoy excellent health, mentally and bodily, who suffer from this affliction. According to the last mentioned authority, incontinence may occur for the first time under the influence of some periodic disturbance of the function of micturition, or of the nervous system, and simply recurs through force of habit long after the primary cause has disappeared.

I should now like to add to these various views my own experience about one cause, which in my opinion is by no means rare, and which in fact is often the source of the most intractable cases of enuresis nocturna.

CASE I.—In the spring of 1885 I was consulted, as family medical man, on account of an intelligent boy ætat. 7 addicted to wetting the bed for some time past, though previously he had been free from this trouble. Examination of the boy revealed nothing at all to account for it; his pale and anæmic look rather struck me. The mother informed me that for some time he had been very irritable, could not bear his brothers and sisters, and liked best to be alone. Further, his schoolmasters had been complaining for a long time of distraction, and want of attention on his part. I attributed the incontinence to an overwrought nervous system and to anæmia, and this latter in turn to over-pressure at school. After a long stay in the mountains during the summer, he returned very much worse. He wetted the bed much more frequently, in addition often had diarrhœa and suffered a good de from flatulency. He was also exceedingly irritable, depress in spirits, and often burst out crying and sobbing without an cause, *e.g.*, when at table, in spite of a really voracious appetit

I could not at all explain the case, until one day the mothe told me that—she had just noticed it for the first time—her bo masturbated dreadfully, and in fact, as he confessed to her, ha been doing so for some time past. Now I altered my diagnosis: the primary cause is chronic inflammatory irritability of the mucosa of the prostatic portion of the urethra, due to masturbation. The former acted reflexly in producing nocturnal incontinence and the latter the anemia and neurasthenia. The remedial measures consisted in preventing masturbation, which was exceedingly difficult to carry into effect, and in the local application of a solution of tannin twice a week to the prostatic urethra. The little patient was in the end completely cured after a good deal of trouble and patience.

Here we have a case where none of the previously mentioned causes existed, but where the mischief lay in the prostatic urethra itself. This is by no means rare; on the contrary, it lies at the bottom of quite a number of obstinate cases of nocturnal incontinence.

If we examine the urethra of a young male subject, Oberländer says the size of the caput gallinaginis strikes us as out of all proportion, standing up like a buttress. It is evident that this eminence when transiently or chronically irritated must be a source of acute reflex irritability. Further, numerous glands belonging to the genital tract open into the posterior portion of the urethra, *e.g.*, Cowper's glands and the vesiculæ seminales. For although these glands do not become active as a rule until puberty, still it is a mistake to assume that their functions are quite dormant prior to this period. That this is physiologically so, is also borne out by the frequent erections of infants and boys. If these erections be at all abnormal in frequency from any particular cause, a chronic inflammatory state of irritability may ensue, which may give rise to enuresis even in boys with no congenital weakness.

As an illustration of this point I may cite the following case.

CASE II.—H. St., ætat. 18, a gardener's apprentice, consulted me in the winter of 1882-83 about his periodically wetting the bed. He did not look more than 15, was pale and anæmic, and although he had a very good appetite, he was always tired, sluggish in his movements, and dull of comprehension. He had never wetted the bed in early childhood; it first began when he was about seven. No family history of this affliction. The penis was very large, and the testicles well developed. He stated he never had nocturnal emissions, and even professed not to know what they were. He strenuously denied masturbation. Examination of the urine more than once revealed leucocytes and urethral epithelium in varying amount, and his landlady on my inquiry told me that the bed linen was very frequently stained. The youth now confessed that ever since he was five he practised masturbation, and kept on doing so to an excessive degree, frequently four or six times a day. He soon felt the consequences; he was often ill in the morning, his head felt oppressed and heavy, he could learn nothing, bodily development was retarded, and he began wetting the bed. Seminal emissions occurred shortly after 14, and when he consulted me, they even took place during the day at erotic thoughts or with certain movements of the body. Latterly nocturnal incontinence had remained about the same. Treatment consisted in introducing full-sized metallic bougies and leaving them in the urethra for some time. As soon as the patient ceased wetting the bed he passed away from under my care, and I have not heard anything further from him.

In both cases I have shown that a chronic irritable state of the prostatic portion of the urethra may be the sole cause of enuresis even in boys whose uro-genital tract had hitherto been perfectly healthy. From both histories we have seen what was the cause which had abnormally increased the number of erections which naturally take place in childhood, and thereby induced this inflammatory condition, viz., masturbation. Ultzmann ("Nervous Affections of the Male Genito-urinary System") states: "Masturbation and venereal excess, in which persistent unnatural erection is kept up for a considerable time, are not infrequent causes of the prostatic urethra, and especially of the caput gallinaginis, becoming hyperæsthetic, hyperæmic, and catarrhal, and consequently stimulating reflexly the contraction of the detrusors."

What then happens when this cause is at work, not in boys previously robust, but in those who are suffering from enuresis nocturna, the result of arrest in the infantile stage, or of congenital muscular weakness of the genital organs?

In such cases two causes are at work—the congenital and acquired vesical weakness, and the results are those obstinate and severe cases of enuresis which continue into manhood and are most intractable.

As examples of this class I may adduce the following cases:—

CASE III.—At the end of October, 1883, S. P., ætat. 17, farming pupil, son of a professor of medicine, consulted me on account of obstinate nocturnal incontinence. The young man was fairly well-developed, and had suffered from infancy from this misfortune; two of his brothers were similarly afflicted, but they outgrew it between the ages of twelve and fourteen.

It occurred in the patient's case once or twice in the night in spite of every precaution and the careful regulation of his habits. He always had light digestible food, extremely little fluid, and never drank anything in the evening. In the course of the night he would be repeatedly awaked by the steward by means of a cord fastened to his foot. At one time it would occur immediately after falling asleep, at another soon after he had been awaked and passed water. Sleep was always remarkably heavy and deep. In the morning he could scarcely be got out of bed, and then he was half-confused, and had difficulty in remembering things. Usually he had quite forgotten he had been awaked in the night. During the whole morning his head was heavy and oppressed. He was exceedingly dull of apprehension, and his condition only began to improve in the afternoon. Almost constant lassitude. Local examination of the genitals revealed nothing abnormal, though they were rather large. Urine normal; after standing some time, a slight cloud appeared at the bottom of the urine glass, consisting of mucus, round small epithelial cells, a few leucocytes, and a fair number of beautiful rhombic prism crystals (coffin-lid crystals*), as are met with at times in the mucus of Cowper's glands. From this discovery I could with certainty infer an irritable condition of the genital organs, and on my inquiry the patient confessed that he had been suffering from seminal emissions at night in consequence of masturbation, and that even during the day they often occurred at erotic thoughts, or with mere friction of the trousers. He commenced masturbation when eleven years of age, and since then nocturnal incontinence had become much more frequent. Treatment consisted in the application of the Psychrophor.* After the first introduction the following night was passed without wetting the bed. Progress became quite marked, and up to Christmas relapses were quite exceptional. From the 1st of January to the end of March nocturnal incontinence occurred but once, and the patient then ceased to be under my care. At the same time his general health greatly improved, the heavy leaden sleep disappeared, he was able to rise at once in the morning and felt cheerful. His intellectual powers improved, he learnt his lessons more easily and willingly, and his shy and depressed manner completely passed away. In the course of six months, having resumed the ordinary habits of life, taking beer and wine, nocturnal incontinence and seminal emissions returned. Local treatment was again carried out, and now the patient is permanently cured.

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* From the resemblance to the lid of a German coffin; they are triple phosphates.—TRANSLATOR.

Case IV.—B., ætat. 18, in the book-binding trade, had been addicted to wetting the bed every night, and suffered from frequent micturition during the day. As he was obliged to earn his living amongst strangers, he would give anything to be rid of his troublesome affection. Father and mother healthy. Two brothers up to the age of eighteen were also troubled with nocturnal incontinence, otherwise they were strong and healthy. The patient was said to have been a strong child, but from the very first suffered from enuresis, which considerably lessened in frequency up to his twelfth year, so that he wetted the bed not more than once or twice a week. About this time B. was taught to masturbate, and practiced it for a year or so. As, however, he noticed that nocturnal incontinence was getting more frequent, he gave up the bad habit. In spite of this step, seminal emissions began to occur when he was fourteen, and later on even in the daytime, especially during any powerful muscular exertion (circling the bar and other gymnastic exer-

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* Psychrophor (ψυχρὸς cold, and φέρω I bear), an instrument for applying cold to the urethra.—Translator.

Forest, Baden, suffered from childhood from incontinence once or twice every night. Of four brothers and three sisters, one brother only suffered from enuresis up to his 18th year.

Patient himself had noticed a marked improvement at the same age, without, however, his trouble completely subsiding. About this time he began to masturbate, and continued the bad habit for a year, when he gave it up, as he noticed his general health suffered. What particularly struck him was that the nocturnal incontinence became much more frequent, and that he now suffered continuously from headache, which he only occasionally had before. Sch. was always tired and languid, and though he no longer masturbated, his condition remained unaltered. It was then he came under my care. The genitals were poorly developed, no phimosis; urine normal; after standing some time a slight sediment was noticed consisting of mucus and leucocytes.

After the introduction of a full-sized metallic bougie enuresis occurred but three times in a period of 10 days. Oberländer's dilator was then used; two relapses only occurred during the following 12 days, and after another application of this instrument the patient was cured.

Case VII.—This case is chiefly interesting because it shows that the enuresis did not depend upon the inflamed long, narrow prepuce, but that the reflex irritation which produced the trouble had its seat in the urethra.

A. Sp., ætat. 13, a thin, miserable-looking lad, had been suffering ever since birth from severe enuresis.

He was always tired, and most difficult to awake in the morning. During the day his head felt heavy, his thoughts were sluggish, and his apprehension dull.

Prepuce long, narrow, reddened, and inflamed, as also the meatus urinarius. For some years he had indulged in masturbation.

Treatment.—The prepuce was slit up, with no improvement, however; thereupon a metallic bougie was introduced daily for some weeks. Cure.

All the cases, III., IV., V., VI., VII., have the following points in common—

1. The patient suffered from infancy from enuresis, *i.e.*, it was congenital.

2. The affection was a family one—father or brother having also suffered.

3. In all (except case VII., which is excluded by reason of the age) sexual weakness was present, showing itself by seminal emissions with flaccid penis, brought on by comparatively trivial causes.

4. *Lastly, in addition to the congenital weakness, another cause was present, namely, chronic inflammatory irritability of the prostatic portion of the urethra, due to masturbation.*

Cases are also observed where wetting the bed at first is a congenital *nocturnal* affection—"enuresis nocturna"; in the course of time, however, micturition may become frequent *during the day* (Case IV.)—"enuresis diurna"; and, finally, it may pass into "enuresis continua," where the patient cannot retain the urine at all. As an example of this condition I take the following case from my book on "Irritable Bladder."

M. W., ætat. 10, small, thin, miserable, and cachectic-looking boy, with red nose and prominent belly, suffered from continuous incontinence of urine. His shirt and trousers after half a day were quite wet, and emitted an evil-smelling urinous odour. The bowels were sluggish. Appetite very good, in fact voracious. Constant languor, heaviness of head, especially in the morning. He could not be awaked out of his sleep, not even by shaking. Intellect normal.

The boy had suffered from infancy from incontinence, which had gradually increased in severity; *there was constant desire to pass water during the day*, and the last two years it became so troublesome as to almost abolish retention, and thus established the condition for which he came under my care.

The lad had never suffered from worms or any other serious illness. The penis is small, the prepuce very long, and the meatus a vivid red.

The urine passed in my presence soon showed a cloudy sediment, consisting of mucus containing rhombic prisms (coffin-lid crystals), and also a number of quite small crystals of oxalate of lime. A few round and oval epithelial cells and mucus corpuscles could also be recognised. The urine itself was free from albumen and sugar, but markedly acid.

The glassy, ropy mucus which had collected at the bottom of the glass, together with rhombic prisms (coffin-lid crystals), &c., showed a marked alkaline reaction.

Before examining the urine, I asked the little fellow whether he ever played with his genitals, but he strenuously denied doing so.

From the results of the microscopic examination I again questioned him on this point, and then he admitted having masturbated ever since he was six, *i.e.*, for the last four years, and *exactly during this period oppression of urine was noticed during the day*, which, as we have seen, passed into complete incontinence.

The treatment—besides explaining to him the consequences of his bad habit—consisted in passing metallic bougies. The first application lasted a quarter of an hour, and the following night was passed without wetting the bed. This treatment was continued regularly for eight days, incontinence was completely cured, and the desire to pass water considerably lessened in frequency.

In order to cure the patient of masturbation, the prepuce was slit up, and a sound was passed at intervals for some time afterwards.

He remained quite well, and exchanged his wretched appearance for a healthy if not a robust one.

What is the explanation now of such a case?

From the outset we must not confound it with that form of enuresis which at times occurs in nervous children, when coughing, sneezing, laughing, when doing gymnastics or coming down hill, &c.

In my book on "Irritable Bladder," I have shown that irritation of the prostatic portion alone is not sufficient to produce vesical irritability, but rather that the frequent and at times constant oppression of urine characteristic of the affection is not established until the neck of the bladder is implicated. The neck is by far the most sensitive region of the bladder, and it is evident that anything that irritates or frets this must heighten its sensitiveness to an unnatural extent, and give rise to frequent micturition, which is characteristic of the affection known as "Irritable Bladder."

If this chronic inflammatory state of the prostatic portion of the urethra and of the neck of the bladder supervenes in a case where there is already a congenital weakness of the uro-genital tract, especially of the sphincter vesicæ, we can easily understand that the patient is no longer in a position to resist the urinary tension under such circumstances, and thus enuresis continua is brought about.

The *diagnosis* of the presence of chronic inflammation of the prostatic portion is, as a rule, not difficult, and the history generally furnishes evidence in support of it. We should always inquire whether the affection was equally troublesome from the very first, or whether it decreased at any particular age—*e.g.*, 12th to 14th year—and then gradually increased, or whether it only appeared for the first time in late childhood (6th to 8th year).

If the patient or the parents are unable to give information upon this point from its very commencement, we must endeavour to obtain it by proceeding along definite lines. For if we have ascertained that the affection became worse at a certain period, then we may assume that some fresh exciting factor has supervened, and we must find out what this is. The best means to this end is frequent microscopic examination of the urine.

If we have an apparently normal urine to examine, we shall find probably by transmitted light and careful scrutiny that it is not quite clear owing to a slight haze. After standing some time a cloud settles at the bottom of the urine glass, which reveals under the microscope mucus and more or less numerous leucocytes. At times we may discover spermatozoa in patients who have passed puberty, or we may notice in the pipette a transparent tenacious alkaline mucus in which epithelial cells or rhombic prisms (coffin-lid crystals) are imbedded. These results indicate chronic inflammation of the posterior portion of the urethra, and relying on them we may now complete the history by telling the patient that such a discovery in young persons is the result of masturbation, and that he may as well speak the truth.

I should here remark that I do not pursue this method without good reasons, for it often happens that such young patients, if we are not almost certain of it, deny masturbating most positively, as is seen in the history of Case II.

We may thus draw our conclusions.

For instance, a young man comes to us ætat. 18, who has been suffering from birth from enuresis, which with the growth of the body has decreased without quite disappearing. Gradually, without any apparent external cause, it becomes again frequent; other nervous symptoms are noticed, *e.g.*, irritable disposition, heavy leaden sleep, difficulty of waking in the morning, and oppression of the head. Examination of the urine yields the above-mentioned results. We can be almost absolutely certain of our conclusion without any admission on the part of the patient—chronic inflammatory irritability of the prostatic urethra due to masturbation, and as a result of the former, aggravation of incontinence and manifestation of neurasthenia.

Treatment.—As regards the general treatment I shall not enter into particulars, for these measures are well-known (*e.g.*, easily digestible nourishment, and avoidance of fluid as much as possible, especially towards evening, prohibition of feather bedding, and methodical bathing).

All these measures, including hypnotism, most recently recommended, are of no influence in such severe and obstinate cases as we have described.

Local treatment only is of service.

Sir Henry Thompson ("Diseases of the Urinary Passages") states, after having mentioned the various remedies and modes of treatment, "if these have no effect, then in those patients who are either approaching, or have passed, puberty, instillation of a 2 per cent. solution of nitrate of silver may be used to the prostatic portion of the urethra. The strength of the solution may be subsequently increased if necessary. In the case of boys, the introduction of a soft bougie every second or third day, and leaving it in the urethra for two or three minutes, as a rule is sufficient."

Although Sir Henry Thompson does not mention in which class of cases the above treatment is indicated, in my experience it is just in such patients I have here described, where a chronic inflammatory irritation of the prostatic portion of the urethra is the cause of all the trouble.

My treatment of these cases consists as a rule in the use of full-sized metallic bougies. These are introduced two or three times a week, sometimes even daily, and allowed to remain in the urethra from three to five or seven minutes.

Instead of bougies, Winternitz's psychrophor may be used, especially when micturition is accompanied by slight smarting, or seminal emissions occur with the penis flaccid.

The application of astringents, *e.g.*, instillation of 1 per cent. or more of a solution of tannin or alum is at times useful. Nitrate of silver I also use, but never stronger than 1 per mille.

Oberländer has obtained excellent results in several cases by means of his dilator. In Case VII. I used this instrument twice with a favourable issue. I have, however, not sufficient experience as yet to enable me to judge whether it yields better results than the treatment I have described above.

Under local treatment I include the application of electricity. The cathode is introduced into the urethra or bladder, and the anode placed over the lumbar spinal cord, or inserted into the rectum. In such a case the cathode acts not only electrically but also as a bougie, by the frequent application of which Sir Henry Thompson has often effected a cure.

RECENT ADVANCES
IN THE
TREATMENT OF CHRONIC DISEASE OF THE SPINAL CORD.

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RECENT ADVANCES IN THE TREATMENT OF CHRONIC DISEASE OF THE SPINAL CORD.

INTRODUCTION.

UP to the close of the first half of the present century the affections of the spinal cord form, as is well known, one of the saddest chapters in the history of medicine. The scanty character of the knowledge of this subject possessed by physicians was equalled by the miserable success of their treatment, and we can understand only too well how it was that, for the great mass of the public, to say that one was suffering from affection of the spinal cord was precisely the same as saying that he was sinking under a chronic incurable disease. This state of matters has undoubtedly changed for the better during the last twenty or thirty years. The astonishing advance which has taken place in our knowledge of these diseases during that time has been accompanied by distinct progress in their therapeutics also, and though the latter has not been quite so marked as in the case of the former, we may nevertheless comfort ourselves to-day with the thought that the prognosis in a number of these affections is distinctly more favourable than it was wont to be. It would, however, be wrong to suppose that this encouraging change for the better is essentially or even mainly due to the acquirement of new remedies (*i.e.*, previously unknown or unappreciated) against disease of the spinal cord. In the first place, progress in diagnosis has proved of pregnant value. We are now, through a more accurate knowledge of the various forms of spinal disease, and through the improvement in our methods of examination, placed in a position to recognise the most of these forms in a comparatively early stage, and at a period in which they are very much more amenable to treatment than they are later. Further, large additions have been made to our knowledge of the effects of the various remedies used in spinal disease, and these have resulted in improvements in their mode of application, and in a more careful estimate of the indications for their employment. Lastly, a great deal that is of importance for treatment has been brought to light by the more thorough study of the causes of these diseases. I will only mention the connection, so much discussed in recent years, between syphilis and locomotor ataxia, Tuczek's[1] proof that disease of the posterior columns can be caused by chronic ergot-poisoning, and the derivation of one form of spastic spinal paralysis from the effects of poisoning by *lathyrus cicera.*[2]

We must not, however, conceal from ourselves the fact that the advances made in the diagnosis and treatment of these diseases do not benefit all those affected to the extent that their outward circumstances might allow. This regretable state of things is due, in my opinion, to two causes. The first of these refers to the difficulties in the way of diagnosis. The recognition of chronic affections of the spinal cord in the earliest stages, that is, when they are most amenable to treatment, requires not only an accurate acquaintance with the various forms of spinal disease, but also such a familiarity with all the methods of neuro-pathological examination as has not yet become common property among all the members of the medical profession. The second cause is that we are at present over-loaded with remedies and therapeutic methods, and the practitioner who has had no great experience of his own finds his choice of a suitable line of treatment for any particular case very difficult. Our armamentarium against spinal diseases is continually being over-furnished with remedies which are thrown into the market, to begin with, without being sufficiently tested, and after a longer or shorter period disappear again from view.

It lies in the nature of things that the former of these two difficulties will not be set aside for some time. But it should be now possible to remove, or at least to considerably diminish, the effect of the latter, and to produce some degree of separation of the chaff from the wheat. The following remarks are intended to be a contribution to this end.

Before we proceed to pass these remedies under review, I think it desirable to make ourselves briefly acquainted with the limitations which are placed on our therapeutic efforts from the physiological properties of the spinal cord, and the nature of the morbid processes which we wish to influence. We must be as clear in our views as possible in regard to what we really can do before making our choice of the means of doing it.

The question as to how far pathological changes in the spinal cord can regress is yet to a great extent unsolved. The difficulties which the investigator has to contend with makes this only too conceivable. I shall endeavour in what follows to sketch the present position of the question as shortly as possible, and in doing so will bring out plainly enough the scanty character of our knowledge.

Morbid changes in the spinal cord are still divided into the two classes of impalpable and palpable or structural. Impalpable changes, that is, such as cannot be discovered by our present means of investigation, must be assumed to be present in a number of affections. Among these are, first of all, spinal neurasthenia, then many cases of hysterical paralysis and concussion of the spinal cord, cases of hysterical paraplegia, probably also the cases of intermittent spinal paralysis, and many cases of toxic paralysis. All these lesions, though likely enough very different from one another, have this in common, that in the great majority of cases complete recovery from them may be attained, though no doubt, as in neurasthenia, they sometimes prove very obstinate, and, as in concussion of the cord, may change apparently into coarse structural lesions.

Several experimenters have worked at the question whether we can have anatomical and functional compensation in such lesions of the cord as incised wounds or loss of substance. Heinrich Müller[3] worked with cold-blooded animals, Masius and Vanlair[4] and Brown-Sequard[5] with pigeons and guinea-pigs, Flourens[6] with rabbits, Eichhorst and Naunyn[7], Dentan[8], Schieferdecker[9], and Eichhorst[10] in a second series of experiments, with dogs. Though these experiments by no means agree with one another in all their details, yet their general result puts it beyond a doubt that the spinal cord, both in cold- and warm-blooded animals, possesses the power, within certain limits, of producing both structural and functional compensation in the case of incised wounds and loss of substance. They have further shown, however, that the extent to which this power is possessed varies very much, not only among different genera, but among the different species of the same genus, and that young animals, as a rule, possess it in larger measure than old.

Among mammals the power attaches chiefly, if not exclusively, to the nerve fibres, and up to the present time, at any rate, restoration of ganglionic cells has not been observed. On the other hand, Masius and Vanlair have observed such a new formation in frogs, and Brown-Sequard in pigeons.*

Observations on the human subject are in essential agreement with these results. They show that both traumatic lesions of the cord and alterations produced by disease may be recovered from; in the case of the latter, however, that the capacity for recovery varies inversely as the extent of the disease, and that, further, the individuality of the patient is of the greatest consequence, affecting both the commencement of the healing process and its ultimate amount.

It is of particular importance to observe that functional by no means presupposes structural recovery. We have several cases recorded showing the persistence of considerable anatomical changes side by side with the disappearance of functional disorders, that is to say, practical recovery.† Anatomically, all that has been ascertained is merely in favour of regeneration of nerve fibres. Narrow fibres with dark borders have been found in the cicatricial tissue that sometimes forms in cases of transverse myelitis after resorption of the liquefied medullary substance.* In a case of fracture of the spine, where the cord had been crushed in the middle of the dorsal portion, Gowers[15] found at the cervical level, besides the ordinary ascending degeneration, a number of very minute nerve fibres, each consisting of a fine axis-cylinder surrounded by myelin. The fibres were smaller than any met with in the normal cord; the appearance was, says Gowers, as if from the lower extremity of the normal fibres there had occurred a growth of new fibres, such as affects the regeneration of peripheral nerves. And Benedict[17] saw in a teased-out preparation from a case of locomotor ataxia delicate threads (newly-formed axis-cylinders?) passing out from a mass of degenerated nerve fibres.

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* These results refer, as I have remarked, only to the cicatricial tissue formed in the cord after incisions and loss of substance, and not to the degeneration of nerve-fibres. In regard to the latter, Kahler's[11] experiments on dogs gave negative results. By crushing a number of the posterior roots he produced degeneration of the posterior columns, the fibres of which, in the main, are formed of direct continuations of the fibres of the posterior roots. In the animals killed a considerable time after the operation there was certainly regeneration of the extra-medullary part of the posterior roots, but on the other hand no sign whatever of regeneration in the intra-medullary portion. Kahler thinks that he is at liberty to conclude from these observations that in systemic diseases of the cord the restoration of disordered functions can only follow from the opening up of vicarious conducting paths, and not from recovery on the part of the nervous elements. This scarcely appears to me a just inference. Kahler's facts only permit us to say that there must certainly be a distinct difference between the capacity for regeneration possessed by the peripheral nerves and that possessed by the systemic fibres of the cord. But from the negative results of three experiments on animals of one particular species to deny altogether that there is any capacity for regeneration on the part of these cord fibres is hardly correct, all the more so as we have observations on the human subject which distinctly favour an opposite conclusion. As to the question how far systemic fibres which are merely morbidly affected, and which have not yet disappeared, can be restored, Kahler's facts teach nothing.

† Schultze,[12] Fox,[13] and Benedict,[14] have recorded cases of this kind where sclerosis of the posterior columns was the lesion.

Our knowledge of the behaviour of the ganglionic cells is still more fragmentary. Nothing is known in the human subject of a new formation of nerve cells in the cord out of the remains of broken-down structures of a similar kind, or out of any other kind of material. And our present information leads us to believe that any regeneration of this kind is improbable. If it could happen at all it would be preferably in the first years of life. Observations have been repeatedly made in cases that have suffered in early life from infantile paralysis and have completely recovered—cases, therefore, where from the clinical appearances we should expect to find the *restitutio ad integrum* of the diseased tissue, and along with it of the diseased ganglionic cells, complete. But in these post-mortem observations there still remained something of the disease recovered from, and the ganglionic cells in circumscribed portions of the anterior horns are found to have completely disappeared. How far morbid changes in the nerve cells can go, and yet keep possible the *restitutio ad integrum*, or at least the recovery of function, we do not know. It is, however, a fact of great importance that, like the fibres, the cells may suffer considerable alteration without becoming useless or failing in their physiological functions. As in the case of the fibres, the persistence of the axis-cylinders is sufficient, so the cells also may be reduced to but a fraction of their normal size and still be perfectly equal to all their work. A case related by Adamkiewicz[18], for example, brings this out in a very striking manner. By the pressure of a tumour on the left half of the lower portion of the cervical enlargement, the cells were reduced to the one-thirty-second part of the normal, and yet this caused no symptoms whatever during life.

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* Charcot[16] records a case of this kind. There had been compression-myelitis from Potts' disease, and complete recovery from the paraplegia had taken place. The cord at the seat of compression was about the thickness of a goose-quill and apparently sclerosed. There were, however, a considerable number of nerve-fibres, with axis-cylinders surrounded with myelin. Charcot leaves it undetermined whether there was a reproduction of all the constituents of the fibre, or whether there was merely a medullary sheath around a naked axis-cylinder Compare Michaud's case quoted in Leyden's Klinik, p. 134.

We are in the dark also as to how far changes in the neuroglia are capable of retrogression. The neuroglia is involved certainly in a large number of acute and chronic inflammatory processes, from which recovery frequently takes place, so that it may be assumed that, up to a certain point, changes in this substance may undergo retrogression. Several observations in pathological anatomy are in favour of this view, such as the slight changes in the neuroglia which have been found after recovery from myelitic processes. This much, however, appears certain, that if it has been transformed into a delicate fibrillar tissue, consisting mostly of longitudinal bundles with a wavy course—a transformation which we often come across in the later stages of chronic myelitis—retrogression in this case is out of the question. Simple changes in the circulation, anæmia and hyperæmia of the cord, may undoubtedly disappear again. But as to whether, and how far, alterations in the vessel-walls, such as proliferation of nuclei, fatty degeneration, and sclerosis, can undergo retrogression, we are still quite in the dark.

From the foregoing it may be perceived that structural changes in the cord are capable of retrogression only to a very limited extent, at any rate are not susceptible of complete recovery to nearly the same extent as molecular alterations. We have to take into account here another circumstance which is by no means favourable from a therapeutic point of view. As not only molecular but also anatomical changes can exist without affecting the functional capacities of the nervous elements, we cannot identify the clinical with the anatomical commencement of the affection.

Changes in the cord may precede by a considerable time the advent of distinct spinal symptoms. This fact gives us an indication of great importance in practice. In the majority of the chronic affections of the cord associated with structural lesion there is probably, to begin with, a stage of merely molecular alteration in the nerve elements. This, which may proceed from disturbances in the circulation, or may be established independent of such, forms the groundwork from which develops the structural change. The earlier treatment is begun, the more may we expect that we have to do, in part at any rate, merely with molecular changes, in other words the greater is the prospect of bringing back things to the normal. Practical experience teaches us every day that these are not merely theoretical considerations. It is a deplorable error to suppose that if our half measures, or expectant treatment as it is called, should turn out to be useless, there will yet be time for some more energetic course. The attitude of waiting observation, which is so often assumed in the case of diseases of other organs with so much advantage, is out of place here, and the short time during which there is still a chance of recovery, or at least improvement, may very easily be wasted away by adopting it. On the other hand, we must not omit to observe that in the choice and management of remedies in the initial stages of chronic disease of the spinal cord it is absolutely necessary to exercise the utmost care. For just as suitable treatment may assist in quieting down the disturbances complained of, and may pave the way for the recovery of the patient, treatment that is unsuitable may have an opposite effect; it may favour and hasten the transition of molecular into structural changes—in other words, may lessen, if it does not destroy altogether, the possibility of recovery. But while I lay stress on the necessity of treating chronic spinal affections as early and as carefully as possible, I would by no means encourage the notion that in old and advanced cases any serious treatment is useless. Even in those cases we are frequently able to put a stop to the continuance of the morbid process, and to bring about improvement; sometimes, though, of course, not often, we may have recovery in the clinical sense of the word, that is, complete subsidence of all the functional disorders.* These results are probably chiefly to be referred to the circumstance that in the affected portions of the cord, in addition to those nervous elements that are markedly diseased, there are others where the process has not gone so far, and where the alterations are in part still merely molecular. The latter are capable of recovery. Bringing them back into sound working order and strengthening those which are still intact give us the conditions in which the functions of those elements that are destroyed or are hopelessly diseased can be taken over by other nervous structures. In this way, to a greater or less extent, we gain compensation. Even advanced cases then present a fruitful field for therapeutic endeavour; but while this is so, a comparison of the results obtained on the whole with those which we get in cases of recent standing, makes it perfectly clear that "*principiis obsta*" must be our guiding principle in chronic spinal disease.

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* This is, perhaps, commonest in cases of myelitis from compression, syphilis of the cord, and anterior poliomyelitis.

This is not the place for a description of the common features in the treatment of all the chronic spinal diseases. The treatment of chronic structural disease is in several important respects different from that of the so-called functional affections. I shall therefore in what follows first take up the treatment of the former group, and afterwards add the necessary observations in regard to the functional affections.

A. TREATMENT OF CHRONIC STRUCTURAL DISEASE OF THE SPINAL CORD.

I.—*Hydro-therapeutic and balneo-therapeutic treatment.*

Among the remedies at our command for chronic organic disease of the spinal cord the external application of water in its various forms plays a very prominent part. Within the last fifteen years this method has unquestionably made a great advance. No doubt our knowledge of the effects of medicinal waters, and of the various ways of employing water, is still very fragmentary, and the indications for the use of these remedies correspondingly uncertain. A great deal of careful observation, however, has been expended on the methods, and we are in possession of certain outlines which practically are of great importance.

The first question which naturally arises is, What are the kinds of baths in general which are suitable in these diseases? Practical experience has taught us something of value in answer to this. The baths that are useful are, in the first place, hydropathy (the so-called water cure), then artificial and natural brine baths, thermal brine baths, simple thermal baths, thermal sulphur baths, chalybeate and carbonic acid baths, mud and peat baths. On the other hand, sea-bathing, bathing in lakes or rivers, vapour baths, and hot air baths are all found to be of no benefit.

If then hydropathy or baths are to be employed, we have first to take into account the temperature of the water, for this determines the intensity of the thermic stimulant. This statement may appear incorrect in view of the fact that in these affections both the cold water treatment and hot baths are employed with effect. But careful consideration makes it evident that these therapeutic methods are not really so different from one another as their names might seem to indicate. What were formerly commonly known as cold water cure establishments (Kaltwasserheilanstalten) have now, if they are conducted on rational principles, dropped the "cold" in their name and become simply water cure establishments (Wasserheilanstalten), in other words, they have dropped any pretensions to using cold water exclusively, and employ baths with high temperatures if a particular case seems to require them. In chronic disease of the cord, physicians in these establishments, as well as specialists and clinical teachers, have invariably found that really cold baths and douches, whether with or without rubbing down, must be avoided in cases of structural lesion. Tepid and cold baths, that is, baths at a temperature of from 90° to 70° Fahr., are the only ones which are employed with success. This is in harmony with our experience of what takes place at hot spas. At all the most important spas of this class in Germany, the general conviction is that these cases are best treated, not with hot baths properly so-called, but only with the water of the hot spring after it has been cooled down somewhat. Even prepared in this way, the patient is kept in the bath as short a time as possible, and some simple hydropathic application, such as pouring colder water down the back, is frequently added. Thus it has come about that there is now no great difference between the treatment by baths as it is practised in hydropathic establishments (Wasserheilanstalten), and as it is carried on by the various experienced physicians at the hot spas. And practically the principles which regulate the treatment in hydropathic establishments, and at the indifferent thermal spas, are the same as we see put in force in almost all the other watering places in Germany to which patients of this class habitually resort.

A rapid glance through recent literature will sufficiently confirm what has been stated in the text. Benedict[19] remarks: "The chronic progressive forms of inflammation with proliferation of the connective tissue require as a rule hydrotherapeutic treatment. The statement admits of few exceptions, that in chronic neuritis, as we have it in such affections as locomotor ataxia and progressive muscular atrophy, warm baths have no retarding influence on the morbid process and do more harm than good." In cases of myelitis, Rosenthal[20] allows of the use of warm baths of from 82° to 86° Fahr., and also half-baths, when the temperature is from 75° to 71° at entering, and from 68° to 64° at leaving the bath. Erb[21] recommends in chronic organic disease of the cord tepid or cool baths, gentle hydropathy, dilute chalybeate baths, and carefully regulated thermal brine baths. Richter[22] says that in locomotor ataxia and chronic myelitis the temperature should range between 90° and 68°, and that anything higher or lower than these figures should be looked upon as involving risk or danger. In another and later communication[23] he gives as the lowest allowable bath-temperatures in organic spinal disease, with half-baths and sitz baths 73° to 71°, with washing-down and the wet sheet 68° to 66°. Winternitz[24] also warns against the use of very cold or very warm baths, or powerful mechanical stimuli, and hardly uses anything else than half-baths of from 86° to 73°. A. Erlenmeyer[25] in cases of locomotor ataxia allows only baths at about 82°. Heller[26] (Teplitz) remarks that in locomotor ataxia the treatment should regularly begin with baths at 86°, following up with simple half-baths, and that in comparatively rare cases a rise of temperature to 90° or 91½° at the utmost may be indicated. Reumont[27] (Aix-la-Chapelle) finds that syphilitic cases of ataxia in the advanced states, and when the constitution is undermined, take best with baths at 89° to 91°, or at the utmost 93°. Voight[28] (Rehme-Oeynhausen) uses in chronic inflammatory affections of the cord, brine baths and thermal brine baths at 88° to 81°. Müller[29] (Rehme-Oeynhausen) recommends the same kind of baths at 88° to 84° in tabes. Stifler[30] (Stahlbad Steben) uses in tabes chalybeate baths at 89°, and Caspari[31] (Meinberg), the aerated baths of Meinberg at 78° to 88°, and never for over ten minutes. Grödel[32] (Nanheim) in tabes to begin with, uses brine baths at 91°, never going below 82°, and in chronic myelitis with increased reflexes, brine baths at 89° to 78°.

Among recent German authorities, Leyden in his text-book on diseases of the spinal cord expresses himself unreservedly in favour of warm baths. His views, however, since then may have changed. Schuster[33] (Aix-la-Chapelle) also has advocated their use. According to him and other physicians in Aix, baths at 95° are for the most part those which have been found of use, while anything colder has acted unfavourably. This hardly agrees with Reumont's experience, and we must furthermore bear in mind that the spinal cases which find their way to Aix are almost exclusively syphilitic cases, and that among them there is no doubt a large number in whom the constitution has been undermined, and who are extremely susceptible to temperature. In France, however, the use of warm baths, especially those at Bourbonne, Aix-le-Bains, Balaruc, La Malou, and Neris, finds a good deal more support. The springs of La Malou, in the department of l'Herault, which are alkaline and gaseous, and contain a little iron and arsenic, are used in baths at a temperature of 86° to 104°. They enjoy a great reputation, and are recommended in locomotor ataxia by physicians of the highest standing, such as Charcot, Combal, and Grasset[34]. But even among these western neighbours of ours a reaction seems preparing. Glax[35] at least warns against the use of either too high or too low temperatures in the hydrotherapeutics of tabes. But it must be noted before concluding that although in the great majority of instances, according to our present information, bathing at a temperature of 91° to 72° will be found most suitable, this is not an absolute rule for all cases of organic spinal disease. Among the cases that have fallen under my own observation there have been several for whom baths at 91° were found to be too cold, and to exercise an injurious influence. I have never hesitated in such cases to raise the temperature to 93° or 95°, and in regard to these temperatures, as in regard to all the other factors coming into consideration in bathing, the effect of the treatment on the patient must be accepted as our guiding line in each individual case.

When we have come to know that for the majority of cases of chronic structural disease of the cord neither cold nor very warm baths are permissible, we have unquestionably made a very important step in advance. But the knowledge must have been purchased at the expense of a large number of bad results. Formerly the same spinal cases were treated in the hydropathic establishments with cold baths, cold washing down, or cold douching, and at the thermal spas with warm or even hot baths. Many patients came to grief in both places, but the results of the spa treatment were particularly bad. Erb,[36] for example, mentions that in more than a half of the cases of chronic myelitis in which he was able to ascertain the result of a course of thermal waters, the patients became worse either during the treatment or immediately after.* A change was certainly called for, and this necessarily led to a reconciliation of the opposition between these two methods.

One form of hydro-therapeutic treatment that is widely used at present, and that can be warmly recommended, is in the form of the so-called half-baths, given at a temperature of 86° Fahr. and under. Friction of the skin is used at the same time with great advantage, as it facilitates reaction while the patient is in the bath; in certain circumstances massage of the limbs may also be used. At the end of the bath I have often, with great benefit, employed the pail-douche over the back, with water 3° to 4° lower in temperature than that of the bath. It must be poured on slowly from no great height, and the quantity must be exactly prescribed—one or two pailfuls at the outside. In using the wash-down the temperature of the water may be one or two degrees lower than the lowest permissible limit in the bath; yet care must be taken that too great energy is not employed in this procedure. Wet packs must not be kept on after the patient is sufficiently heated up, and must be followed by a wash-down at the same temperature as the pack, or by a half-bath of short duration. For the class of diseases we are now discussing the cold douche is inadmissible.

We have become almost all over much more cautious lately in regard to the duration of baths, as well as in regard to their temperature. Here again bad results have played the schoolmaster. Winternitz recommends for half-baths at 86° and under a duration of 6 to 10 minutes. In the last year or two I have been accustomed to order half-baths to be of never more than 6 minutes' duration—on an average, about 5. It is a good plan to make the duration short in proportion as the temperature is low. The wash-down should only take up a very short time, half, one, or one and a half minutes. At the "indifferent" thermal spas also they have become converted to the use of baths of very brief duration. V. Renz[37] (Wildbad) speaks of a duration of 5 to 10 minutes. Heller (Teplitz) applies in tabes, to begin with, baths of 5 to 8 minutes, and only rises gradually to 10 to 12 minutes. Voigt (Rehme-Oeynhausen) prescribes simple and thermal brine baths of 5 to 15 minutes. Gródel (Nauheim), in tabes, brine baths of 10 minutes (rarely 15). I myself, up to the present time, have used artificial brine baths of never more than 10 minutes' duration.

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* Among 22 cases of chronic myelitis treated by hot baths that Erb had under observation, there were 12 in whom this treatment (at Wildbad, Teplitz, and elsewhere) proved distinctly hurtful, and 7 in whom it had no effect at all. Only 3 cases improved, and in 2 of these the water was cooled down for the bath, the patients were kept in for only a short time, and only a limited number of baths were given. *Facta loquuntur.*

I may here remark, by the way, that we require to pay some attention to the proportion which the water in this latter kind of bath bears to the salt or brine. A brine bath, it is well known, should properly speaking contain at least 2 per cent. of salt (many authorities say 3 per cent.); 60 gallons of water, which would about fill an ordinary tub, would require in this way 12 lbs. of salt. If any one is unwilling to begin with this proportion, it is at any rate advisable to rise to it in the course of time.

When we come to consider the special indications for all these different forms of bath, we must acknowledge that there is still a good deal of obscurity here. But the choice of a bath, or the choice of any particular kind of bath treatment, does not depend simply on the form of disease from which the patient is suffering. Other considerations that must be taken account of are: the duration of the disease, the prominence of particular symptoms, the constitution and general state of nutrition, the complications that may be present, the season of the year, the place from which the patient comes, and the patient's pecuniary circumstances. It is certain, it appears to me, that, at any rate in a large number of the cases that are capable of improvement, the end may be attained in several ways, and not merely by one particular form of bath treatment. The cold water cure, at any rate, admits of very wide application. There is, according to my experience, no form of spinal disease for which it is not suited. The number of modifications which the various steps in the method admit of, allow of its being adapted to a very great variety of affections. And one great merit it has, is that it is applicable all the year round, whereas the usefulness of most of the spas is limited to one particular season. There are, however, often enough individuals who are unable to bear even the very mildest parts of the treatment, and who would come to harm if it were persisted with. This is most commonly the case with patients who suffer from intense feelings of cold in the extremities, and who dress in the hottest summer months in flannel and felt shoes to keep themselves properly warm; also in wasted and anæmic individuals, and in those who have been spoiled by too much tender care. For these classes thermal baths and weak brine baths are particularly suitable. The warmer thermal baths are said to do especially good service in the various forms of meningitis where the substance of the cord is not much affected. But further trustworthy observations are desirable on this point. The stronger brine baths and the thermal brine baths are indicated in scrofulous constitutions, and the spinal affections associated with diseases of the bones, and in the exudative forms of meningitis, where we may look for absorption of the exudation from any stimulus given to the tissue-metabolism. The thermal brine baths (especially those of Rehme-Oeynhausen) go very well along with hydropathy in various other spinal affections, especially sclerosis of the posterior columns. Sulphur baths do very well in the lesions which follow syphilis when associated with other distinct evidences of the continuance of the infection. Nobody now says that these baths have any specific effect on syphilis; even the physicians themselves (Reumont, &c.) at sulphur spas merely rely on their beneficial influence on the skin as a valuable aid to an anti-syphilitic course. This influence, however, undoubtedly belongs to other kinds of baths also; the fact that the physicians at these spas insist on particular routine courses in their treatment of syphilis appears to me to be much more important. Chalybeate baths are indicated in anæmic and reduced conditions, but only when the morbid process is rather a slow-going one, and in patients who are not in a nervous condition. For patients who are, or who show marked evidence of spinal irritation, the stimulating effect of the carbonic acid in the chalybeate waters renders their use undesirable. We have at present no very precise indications for the use of the carbonic acid waters in baths, and the same may be said of mud and peat baths.

A number of other points have to be taken into consideration in coming to a conclusion about a course of baths. Patients with disease of the cord do not bear the exertions of a long journey very well, and this is especially the case if the disease is advanced. They should not therefore be sent to spas far from their own homes, or the journey to which is difficult. Little good is attained with the usual four weeks' residence and 18 to 20 baths, and the patients ought to make up their minds to a stay of from two to three months, or even longer in some cases. It is advisable to make this quite clear to begin with. When a course of baths is indicated at all, the time of year should not be suffered to stand in the way, as, at any rate, the water cure and brine baths (the most important forms of treatment in spinal cases) can always be put into operation.

We must say something about the local thermic applications to the spinal column. Moist warmth in the form of fomentations and poultices to the back is scarcely ever made use of now. I certainly think the former could hardly be expected to exercise much effect on the lesion under discussion; hot poultices, hot sand-bags, or hot water in Chapman's bags, offer hopes of better results. According to Chapman,[38] warmth applied to the spinal column produces hyperæmia in the affected portion of the cord, and at the same time removes the congestion and feeling of heat from the peripheral parts which derive their nervous supply from the portion in question. On the other hand, he holds that cold lowers the circulation in the cord, and after some time raises the temperature at the periphery. I must acknowledge that I have not been able to verify this theory in my own experience, nor am I convinced from published cases that the successes of the method are arrived at in the way Chapman thinks. But I have certainly seen benefit in a number of cases from the application of cold by means of Chapman's bags. There have been, particularly, affections of the cord where both the meninges and the vertebræ have been involved, as in tumour of the cord and myelo-meningitis. I have seen good also in some cases of lightning pains in locomotor ataxia.*

The special advantage, apart from the ease of application, which these bags offer is that they allow of the careful regulation of the thermic effects; in this way the temperature which exactly suits the patient can be obtained.

II.—*Electro-therapeutics.*

The most distinct step in advance in the treatment of diseases of the spinal cord within the past twenty or thirty years was achieved by the introduction of a rational system of electrical therapeutics. Nothing else in our whole armamentarium has greater successes to show, and no other remedy used in these diseases has been so generally recognised in all civilised countries.*

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* Instead of Chapman's bags, Leiter's coils may be used.

Of the forms of electricity at present used, the constant current is undoubtedly the most valuable. With regard to the method of its application, there is at present a distinct preponderance of opinion that there should be a direct influence on the diseased portion of the cord, and that the current should traverse this as completely and equally as possible.

To get this done without using very strong and painful currents, we must seek the help of all the physical appliances adapted to facilitate the entrance of the current into the spinal canal. We place one electrode over the spine at the affected region of the cord, and the other as nearly as possible at the same level on the anterior surface of the body, so that the greatest density of the current passes through the diseased portion; or we can place both electrodes over the spine at some distance from one another, so that a large portion of the current must necessarily pass through the spinal canal. Further, we use on well-known principles large flat electrodes, and moistening these well with warm water apply them with as firm and equal a pressure as possible. According to my experience the most suitable for the majority of cases are rectangular plates of 50 square centimetres (5 by 10). In individual cases, now and then larger plates may be required; W. Müller recommends 70 square centimetres, and v. Ziemssen's giant plates are 100 square centimetres and over. These exceptional sizes are used particularly in cases of circumscribed disease, and where the body is well nourished, but as a rule they offer no particular advantages. In the case of spare individuals especially, the difficulty of applying them exactly makes the advantage of their larger size often a very imaginary one. Seeligmüller's spinal electrode again appears to me of even less value on account of its surface being too small. In the case of children of course smaller plates are used; 3 by 6 cm. is a good size.

At present, of the two methods mentioned above, the former with the current passing horizontally is the favourite in the case of circumscribed lesions, while the latter with the current passing longitudinally is chiefly used in the so-called systemic diseases, in which the lesion is distributed in the longitudinal direction of the cord. One pole is applied to the neck and the other to the lumbar spine, and while the one is stationary the other is moved slowly along and brought nearer the first. But even in circumscribed lesions it is advantageous to make use sometimes of the longitudinal current, with one pole moving along the neck, and the other stationary at the seat of disease; also a horizontal current, or one that is approximately horizontal, may be used in longitudinal lesions, one pole being stationary on the front of the body and the other moved along the spine. The latter pole is moved about the breadth of the electrode at a time, and is kept at each spot for from twenty to forty seconds. The direction of the current with this method is, according to many authorities who speak with great confidence on the subject, a matter of no consequence; others speak with less assurance, and acknowledge that in certain respects it might not be quite a matter of indifference where the positive pole was applied, and where the negative. It would take me too far if I were to go fully into the whole matter, and I must content myself with stating shortly my own views, which are based on experimental investigation and clinical study.

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* On the other hand, the use of balneo-therapeutics, which plays so large a part among us in Germany, is in England almost a *terra incognita.*

The statement that the direction of the current is of no consequence if meant to be of general application is correct neither for the horizontal nor for the longitudinal current, though it must be acknowledged that in many cases it is a matter of indifference in treatment. When the current is used longitudinally with one electrode applied to the neck, the ascending current should be first tried if the case is recent, and there is probably hyperæmia of the cord; that is, the negative pole should be applied to the neck, and the positive pole below. In older cases, and especially if there are no symptoms of irritation of the roots, the descending current. With the horizontal current the anode alone is to be applied to the back, especially if there is anything pointing to a condition of irritation of the posterior roots, such as pain or girdle-constriction.*

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* Compare in this connection my "Investigations in the Electro-therapeutics o the Spinal Cord," Munich, J. A. Finsterlein, 1883, pp. 7, 28, and particularly 60–66.

In many cases the galvanic current has been found very useful in the treatment of painful or tender spots over the spine. Although such spots are not very common, yet where they do exist they require special looking after. The method employed is to apply the anode stationary over the part affected. Some observers endeavour to attain an effect on the cervical sympathetic along with the galvanisation of the cord. A method strongly recommended by M. Meyer, of Berlin, and Erb for this purpose is to apply the kathode stationary at the angle of the lower jaw, while the anode is gradually moved down on the opposite side of the vertebral column, close beside the spinous processes. This method has one disadvantage, that giddiness and stupor are easily caused unless very gentle currents are made use of.

A combination of central with peripheral galvanisation has been very much employed in paralytic and anæsthetic conditions in the extremities. The one pole is applied to the spinal column, the other over a plexus, nerve trunk, muscle, or group of muscles. I myself prefer in general to use peripheral and central galvanisation separately; at any rate, in making use of the nerve currents through the spinal cord it is reasonable enough to employ the latter by itself. If there are disorders of the bladder, rectum, or sexual organs, these parts, as far as possible, should be included in the circuit. In paralysis of the bladder the one pole is placed over the lumbar spine, the other alternately over the symphysis and perinæum, or separately over the one or the other, according as we wish to affect principally the detrusor or the sphincter. Passing the current from the lumbar region to the perinæum is a method which may also be employed in paralysis of the sphincter ani or affection of the sexual powers. Any internal electrical treatment of the bladder or rectum is generally unnecessary.

In applying galvanic electricity in these various ways we must take account not only of the strength of the current, but of the transverse section of the electrodes, that is, of the current-density. For the expression of this, C. W. Müller[39] has proposed the formula—

$$\text{D (current-density)} = \frac{\text{I (current strength in milliampères).}}{\text{Q (section of electrode in square cm.).}}$$

Erb[40] was the first to lay stress on the necessity of paying attention to the current-density as well as to the current strength; but this way of looking at the subject has only been generally recognised during the last three years, and since the publication of Müller's investigations. If we compare the current-densities used now-a-days in the treatment of spinal disease with those which, so far as can be ascertained, were customary in the first years of galvano-therapy, we find all over a tendency to the use of much weaker currents. Nevertheless there are still very great differences between the views of various authorities. Lewandowsky[41]* allows in the direct treatment of the cord a current-density of from $\frac{1}{40}$ to $\frac{1}{20}$, at the utmost $\frac{1}{18}$. Müller[42] with his method of passing the current horizontally and shifting the electrode along the spine as has been described, allows generally about $\frac{1}{18}$—to put it more exactly $\frac{4}{72}$; in circumscribed lesions he employs on an average $\frac{3}{55}$, but may go at times as low as $\frac{1}{36}$ or less. Erlenmeyer[43] does not go beyond $\frac{4}{137}$. On the other hand, Remak[44] holds that it is not at any rate indispensable to have currents so weak as these in order to get good results; he comes to this conclusion because "the early successes which insured the adoption of the method were, so far as we can estimate now the strength of the currents used by R. Remak and his immediate successors, attained with very much stronger current-densities" than those quoted above. And Bernhardt[45] recommends in tabes current-densities of $\frac{6\text{—}15 \text{ M. A.}}{50\text{—}50 \text{ square cm.}}$, while De Watteville,[46] in chronic myelitis, uses 20—40 elements which certainly correspond to much greater densities than those employed by C. W. Müller and Lewandowsky. Erb[47] advises the use of weak currents in the direct treatment of the cord, at the same time speaking of densities of $\frac{5\text{—}20 \text{ M. A.}}{60\text{—}100 \text{ square cm.}}$ as "sufficient."

In utilising actual experience for the purpose of estimating the current densities we are to employ, there are two or three conditions which I have long thought must be observed. First, the cases on which we are to found must have been treated by electricity alone. Second, both the immediate effect of single sittings on the condition of the patient, and the ultimate general result, must allow of no doubt of the beneficial results of the treatment. Third, *cæteris paribus,* old stationary cases give a surer basis for an estimate of effects than recent cases.

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* I must not omit here to notice Lewandowsky's excellent work on "Electro-diagnosis and Electro-therapeutics," which was published last year. His careful treatment of the matter from the side of elementary physics is specially adapted to the needs of the physician, and makes the book a capital introduction to the subject.

With a careful regard for these conditions, my own experience allows me to say that in organic spinal affections current-densities of $\frac{1\frac{1}{2}-5}{50}$ should be employed; a density of $\frac{3\frac{1}{2}-4 \text{ M. A.}}{50 \text{ square cm.}}$ is about the average. It is well always, however, to begin with lower densities than these, and to rise gradually; if there are well-marked symptoms of irritation present we should keep by the lower densities.*

The duration of the sitting also in recent years has been very generally shortened. While formerly it extended frequently to ten or even fifteen minutes, there are few physicians now who let it last beyond five minutes, and many will not go beyond three. I think that, as fair averages, from four to five minutes for the whole cord, and one and a half to three minutes for any portion, will be found satisfactory; at the same time these figures must only be worked up to gradually.

The necessity of being provided with a galvanometer does not now-a-days stand in need of argument. We get no trustworthy standard to go by, or almost none, from the patient's sensations. Measuring the current by the number of elements used is just of as little value, because the electrical conductivity over the back varies very much, not only in different individuals, but also in different parts of the back in the same individual; besides, the activity of most of the elements usually employed is anything but a constant quantity.

The induced current also is extensively employed in these spinal diseases. It is much less suitable for the direct treatment of the cord than the continued current, and it is recommended that when used it should be alternated with galvanic currents of moderate strength. But its peripheral application is a matter of greater importance, and is much commoner. The faradisation of nerves and muscles in spinal paralysis of the extremities is a method much used to counteract the nutritional disorders in the neuro-muscular apparatus brought on by want of exercise, or by the absence of trophic currents from the centres. This procedure is often followed by very remarkable success. It is not necessary to believe that we have here to do merely with peripheral and local effects, and that the results in question are produced by such. The unavoidable irritation of the skin (perhaps also the stimulation of the sensory muscle nerves) acts reflexly on the cord; in this way it is possible, as I have already pointed out in my investigations on the electro-therapeutics of the spinal cord, that faradisation of one leg might increase the motility of the other. The application of the faradic current to nerves and muscles requires therefore some caution; with too strong currents and too long sittings we may easily over-stimulate and thus injure the cord.

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* There is still considerable difference of opinion about the current-densities which may be used in disease of the cord. I should like to draw attention to the fact which has been brought out by Stintzing's[49] investigations, that the current-density necessary to obtain a certain effect at some distance from the surface of the body varies inversely as the transverse section of the electrode. The current-density $\frac{4}{72}$ is therefore not the same in its effects on the spinal cord as $\frac{1}{18}$, as C. W. Müller and Lewandowsky assume; it is greater than the latter, though it does not admit of precise valuation. Nor can we assume that with a given current-density, say $\frac{3}{50}$, the current-density in the spinal cord will always be the same. The vertebræ and soft parts surrounding them, like the skin, may be different in different persons in respect of electrical conductivity, and in one case a current of $\frac{3}{50}$ may give the same current-density in the cord as is given in another case by a current of $\frac{4}{50}$. It is useful to keep ourselves familiar with these facts in order not to fall into any great delusions about the precision with which we measure our currents.

But while the reflex effect in this application of the current is accessory and unimportant, there is another method used in which we make it our only, or at any rate our chief, object to gain this effect: I mean the faradic stroking of the skin, particularly according to Rumpf's plan. The positive pole is placed over the sternum, while the wire brush, representing the negative pole, is moved up and down the back and the affected extremities, touching all the parts several times, and producing distinct redness of the skin. This is done twice over, beginning with the back each time, and such a strength of current chosen that the feeling is midway between mere sensation and pain. The whole sitting should last about ten or twelve minutes. This treatment in the hands of Rumpf[49] (Bonn) has given very good results in a number of cases, especially in locomotor ataxia, where he has generally used it along with antisyphilitic remedies. Eisenlohr[50] also has had good results. I have been like Remak[51], and have been less fortunate with it; in the hands even of Rumpf himself it has miscarried sometimes.*

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* It must be noted that if the method is to be carried out as Rumpf would have it, and considerable redness produced in the skin, it cannot always be done without causing pain, and on that account it does not admit of indiscriminate application to every patient.

The method seems to me generally more fitted to be an adjunct to the galvanic treatment, and I found it a valuable help when locally applied for anæsthesia of the skin and mucous membranes, paresis of the bladder and rectum, prolapsus ani, lightning pains, &c. For the last-named, and in anæsthesia of the skin, the pencil is applied over the region of distribution of the disturbance, but in anæsthesia of the rectal or vaginal mucous membrane, or in paralysis of the bladder or rectum, it is placed about the anus or perinæum.*

The value of Rumpf's method deserves to be very carefully weighed, especially in locomotor ataxia. We require a more extensive experience, however, in order to recognise in what class of cases the method is particularly indicated, that is, in what kind of cases it is of more value than the treatment with the constant current.

Electric baths, both galvanic and faradic, have been recommended in the last few years for a great variety of nervous affections, but in diseases of the cord I have seen little or no benefit follow from their use.

I must mention, lastly, statical electricity, which has recently been again brought forward. It was tried in spinal diseases twenty years ago by Fieber,[52] and Schwanda,[53] and was subsequently strongly advocated by Clemens[54] (Frankfurt). Lately, Morton[55], of New York, claims to have gained a brilliant result by its means in a case of locomotor ataxia. But my own experience of it has been so very unsatisfactory, that I have given it up altogether in organic spinal affections. I readily allow, however, that we are not yet in a position to pass a decisive and final judgment on its therapeutic value in these diseases.

The total duration of a course of electrical treatment is dependent on several circumstances. The chief of these are the amount of perceptible success, the nature of the disease, and the possibility of the application of other methods of treatment. There are but few cases in which weeks will be sufficient, generally months will be required, and frequently enough even longer periods. In some affections, especially in tabes, a course of electricity should be repeated every year for some years.

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* S. Löwenfeld, Investigation on the Electro-therapeutics of the Spinal Cord. Part VII.: On the Therapeutic Effect of the Faradic Brush in Spinal Affections. I must direct attention here to the necessity of carefully disinfecting the brush-electrode after each use of it on account of the danger of communicating syphilis by its means. I am in the habit myself of using the spirit lamp for this purpose.

Electrical treatment may very suitably be used along with baths, and the other remedies of which we have yet to speak (drugs, massage, &c.).

Erb[56] makes a very just remark when he says that "it is well not to take the matter of electrical treatment too lightly." Of course here, just as in other departments, we must not expect every physician to be an expert, and the mere possession of more or less elaborate apparatus does not make him one. The subject of diseases of the spinal cord is surrounded with difficulties, and whoever wishes to gain success in it with electricity, and to avoid doing harm, must be at least tolerably well acquainted with the handling of all the usual apparatus, and with their effects on the human body. Cases of spinal disease are, as a rule, not well adapted for apprentice efforts in electrotherapeutics.

III.—*Treatment by Derivatives.*

Until the last fifteen or twenty years the treatment of chronic affections of the cord by derivatives was universally one of the principal methods adopted. We can recognise very well the extent to which it was trusted from a remark made by Marshall Hall,[57] to whom the pathology of the nervous system owes so much. For inflammation in the spinal canal he recommends in acute cases cupping, and in chronic cases setons and issues as the most effective treatment they possessed. In Germany this derivative method has been forced quite into the background by the advances of hydro-therapeutics and electricity, but in France and England it still finds application, and apparently even more extensively than ever; one eminent French physician, Dujardin-Beaumetz, is even yet inclined to give it the very first place in the therapeutics of these diseases.*

The general theory of counter-irritation is that it relieves the congestion around the spinal cord, and in this way forms the starting-point for, and facilitates the absorption of exudation. This is only partially, however, in harmony with actual facts.

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* Dujardin-Beaumetz. Lectures on Clinical Therapeutics, Vol. III., Part I.: Treatment of Diseases of the Nervous System, Paris, 1883, p. 282 . . . . the derivative method which clearly takes the first place in the treatment of diseases of the cord.

There are, I think, two kinds of effects produced by the application of derivatives to the back.

1. A direct effect on the nervous elements in the cord from the stimulation of the nerves of the skin or subcutaneous cellular tissue at the spot at which the counter-irritant is applied. According to the locality and the particular condition of the spinal elements affected this stimulation of the cells and fibres of the cord may either produce or may inhibit reflexes, or may modify to a certain extent the irritability of the cord without this being indicated in any particular way.[*] Accordingly we have diminution or disappearance of any symptoms of motor or sensory irritation, such as spasm, contracture, pain, paræsthesiæ, or increased reflexes. On the other hand, however, the irritability of some of the nerve elements which have been suffering from damage to their nutrition may be increased and inhibitions removed.

2. An effect on the circulation and nutrition in the spinal canal. This may happen in two ways: (*a*) Through a reflex influence on the vascular nerves of the cord, transmitted from the cutaneous nerves or nerves of the subcutaneous cellular tissue, affected by the counter-irritants. The possibility of this has been proved by Brown-Sequard's[59] and my own[60] experimental observations. (*b*) Through changes produced in the nutrition of the soft parts over the spine. The nutrition of those parts has intimate mutual relations with that of the spinal cord, as the blood vessels and lymphatics supplying both the soft parts covering the vertebræ, and the vertebræ themselves, have numerous communications with the vessels and lymphatics of the cord and membranes. Any morbid processes, therefore, which produce a considerable change in the nutrition and blood-supply of the surrounding parts must exercise a certain influence on the nutrition of the spinal membrane and the cord itself.

The ordinary derivatives may be divided into weaker kinds, such as dry-cups, sinapisms, painting with iodine, and blisters;

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[*] The possibility of "latent" effects of this kind has been proved by the observations of S. Mayer[58] (Prague). He noticed in the rabbit that, after division of the sciatic nerve, indications of motor irritation in the spinal cord presented themselves under certain conditions (exclusive of central influence) which were not observed in animals under these conditions in whom the sciatic had not been divided. The section of the sciatic must therefore have produced some permanent change in the irritability of the cord, though this only came to light in these certain circumstances.

and stronger, such as caustic pastes, moxas,* and the actual cautery. Midway between these two classes are setons and issues, and the repeated application of faradic electricity with strong currents. Experience teaches that in the class of cases we are at present discussing, not much is to be looked for from the milder derivatives; they may be used at times, however, as aids to other methods of treatment, or applied for particular symptoms, especially pain in the back. Setons and issues have fallen very much into discredit in Germany. Yet Dujardin-Beaumetz[61] considers the seton to be one of the most powerful revulsives, and holds that it is particularly indicated in lesions of the brain and upper part of the cord. Stroking the back with strong faradic currents is a very powerful cutaneous stimulant, and can be applied as often as we like, as it produces merely trifling and transitory changes in the skin. But whether this method by itself is capable of producing permanent effect seems to me to need proving, and while it is a very painful proceeding, we can also hardly look upon it as under all circumstances quite harmless. The best counter-irritants are the stronger ones, especially the actual cautery, the beneficial effects of which in some spinal affections are not to be denied. Its application, however, is not without various difficulties and even dangers. It is well known that spinal cases are very subject to trophic disorders of the skin, and that wounds in such cases heal with some difficulty. Especially where there is anæsthesia, there is very great danger that any destruction of tissue, whether intentionally produced for therapeutic reasons or accidental, may extend further. Moreover, in the lower parts of the back even very slight irritation of the skin may lead to the so justly dreaded bed-sores. Finally, there may be considerable pain caused, and the general well-being interfered with on that account; there may be disturbance of sleep in consequence of the difficulty of lying on the back; and in certain circumstances there may be loss of strength from profuse suppuration. For all those reasons pustulants and caustic pastes, and even the actual cautery, have been falling recently more and more into disuse, and physicians are contenting themselves with employing Pacquelin's thermo-cautery to produce the so-called *pointes de feu.* Dujardin-Beaumetz[62] would have these *pointes de feu* arranged in parallel rows on both sides of the spine, and renewed every eight days. Ball[63] thinks it sufficient to touch the skin very lightly at a few points with the actual cautery, but he finds that this requires to be repeated every two or three days.

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* The moxa is a form of cautery which has long passed out of use in this country. The most usual moxa was a pellet of cotton wool soaked in nitre.—Tr

Among the diseases in which counter-irritation is found suitable, the first place is taken by those affections which originate from disease of the vertebræ. Charcot himself reports five or six cases of Pott's disease in which application of the cautery on both sides of the spinous processes at the seat of the deformity removed paralytic symptoms which had persisted for a long time. Althaus[64] recently adopted this plan in a case of paraplegia from caries of the vertebræ after other remedies had failed; the case completely recovered. Next in point of suitability for this line of treatment come the various forms of meningitis, especially chronic pachymeningitis. Last of all, simple chronic transverse myelitis. Benedict[65] has recommended *pointes de feu* in the lightning pains of locomotor ataxia, applying them to the side of the spine about the level of origin of the affected nerve roots. As we now possess some very effective drugs, however, for these pains, there is not much opportunity for making use of Benedict's suggestion.

IV.—*Treatment by Drugs.*

We cannot on the whole say very much at the present day in favour of the treatment of these diseases by drugs, and yet we cannot well do without them. Only a very small proportion has survived of all the drugs formerly used. Among those which have answered the tests of experience the preparation of silver, mercury, and iodine are distinctly the most important. At present, for organic lesions of non-syphilitic origin, nitrate of silver enjoys the best reputation. Wunderlich,[66] as is well known, was the first to recommend it, and, in addition to him, a host of eminent observers have reported favourably of its effects, especially when used in posterior sclerosis; the latter disease even at present forms the chief field for its use. The dose varies in different authors, from a seventh of a grain to half a grain three times a day. I generally order a seventh of a grain three times a day in the form of pill to begin with, and after some weeks gradually increase the dose to about a third of a grain.* Friedreich has drawn attention to one danger attending the use of silver—the possible production of nephritis. This danger on the whole, however, appears to me to be a far from imminent one, and can easily be avoided with a little reasonable caution. A very singular thing about nitrate of silver is the unequalness of its action : in some cases it exercises a most distinct influence for the better on the morbid process, while in others, and these the majority of the cases, it does no good whatever. Some authors, therefore, have proposed lately to substitute some other silver salts for the nitrate. Thus Hamilton[68] of New York recommends the tribasic phosphate of silver as better than the nitrate in posterior sclerosis. He gives from three-tenths of a grain to three-fifths of a grain in the form of pill for several months. Eulenburg[69] thinks that the failure of silver in many cases arises from the fact that it arrives in the bowels in a reduced condition, and does not circulate as a soluble chemically active compound. He has attempted accordingly to replace the silver nitrate taken through the mouth by the hypodermic injection of the soluble salts, the phosphate of silver, and particularly the hyposulphite of soda and silver. Rosenthal[70] (Vienna) however was dissatisfied with this, as these salts are uncommonly easily decomposed, and besides produce local irritation. On the other hand he had noteworthy results with the subcutaneous injection of a solution of acetate of silver, using 5 to 8 minims of a ·5 per cent. solution. He treated five cases in this way; in two the ataxic symptoms improved very much, two were unaffected one way or another, and in the case of the fifth, indurations made their appearance in the skin, and along with these an increase in the lightning pains. The great susceptibility of the skin to hypodermic injections in cases of ataxia has always prevented me from heartily adopting these methods.

Besides nitrate of silver, iodide of potash is the drug most used at present. The special indications for its employment, however, are rather uncertain. It seems to do good service, especially where the meninges are affected both in uncomplicated chronic meningitis and in meningo-myelitis. But it is in lesions of the cord of syphilitic origin that most is expected of it, and undoubtedly a large number of cases of this kind have benefited from iodide of potash. Yet, in my experience, it is a very untrustworthy remedy in severe cases of syphilis of the cord if used alone, and mercury, especially in the form of inunction, is much more effective. Many physicians give the iodide along with inunction; others recommend alternating courses of inunction and iodide. My own observations, however, lead me to believe the former to be the more effective.

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* Bokai[67] gives a very good method of preparing pills of nitrate of silver. In order to avoid the reduction of the salt he uses only kaolin in making them, with the addition of a few drops of water, and prescribes at a time only the number required for a day or two. The patient must take the pills fasting to avoid the action of the hydrochloric acid of the stomach, and must drink milk afterwards.

The important share which is now-a-days allotted by many observers to syphilis in the causation of locomotor ataxia made it inevitable that the attempt would be often made to arrest this disease by specific treatment. The time has not yet arrived when we can form a decisive opinion on the value of this method. A large number of authorities have reported favourably, among others, Rumpf[71] particularly, then Fournier,[72] Erb,[73] Eisenlohr,[74] Reumont,[75] Benedict,[76] Gowers,[77] Pribram,[78] Schulz,[79] Berger,[80] Hammond,[81] and Strümpell[82]. Only a few cases, however, of complete recovery have been recorded (Rumpf, Fournier, Schulz, Berger, Landesberg[83]), and in these it is at least questionable whether the symptoms depended on degeneration of the posterior columns, and not rather, as Berger thought in his case, on other lesions, either meningitis or multiple neuritis. They were almost all cases in which the symptoms of tabes developed in a comparatively short time, and much more quickly, at any rate, than is usual in typical instances. Distinct improvement has been observed in a larger number of cases. But alongside these facts we must not fail to notice that in the great majority of cases of locomotor ataxia antisyphilitic treatment has proved useless, and that, frequently enough, the patients have even got worse under it. So far as my own experience goes, as a whole, it has not been particularly favourable to the method. Yet in one syphilitic case in whom the symptoms of tabes developed in a few weeks, the use of iodide of potash along with hydro-therapeutics and electricity was followed in a relatively short time by complete and permanent recovery. But another similar case, in which, however, the existence of syphilis was doubtful (patient had had a chancre, but no secondary symptoms), recovered equally well without any specific treatment whatever.*

The lesson taught by all these observations is this, that while specific treatment in tabes is to a certain extent justified, we must by no means look upon it when used alone as a panacea. It gives the fairest prospect of success in those cases (1) in which no great interval has elapsed between the infection and the first tabetic symptoms; (2) in which, apart from syphilis, there has been no other cause of any importance; and (3) in which the disease is yet in the initial stages. The longer the interval between infection and the appearance of spinal symptoms, the longer the latter have already existed, and the more advanced the disease is, the less can we expect from anti-syphilitic treatment; although it must be allowed that sometimes success has been attained even in cases where a considerable interval has elapsed before the appearance of the tabetic symptoms, and where they have already lasted for many years (Rumpf[84]). But this corresponds perfectly to what we know of the effects of specific treatment on syphilitic affections of the central nervous system generally. It is possible to suppose that the virus still remaining in the body (the syphilitic microbes) is destroyed or rendered innocuous by the treatment, and that further deleterious working on the spinal cord is checked. It is possible further to suppose that retrogression of the syphilitic changes in the vessels, neuroglia, and meninges is initiated by the treatment. But it is not conceivable that we can in this way start the re-formation of fibres that have disappeared. On the other hand, it is not only conceivable, but has been repeatedly proved by experience, that when a degeneration of the posterior columns has become thoroughly established, a vigorous course of mercury may do great harm. By its weakening influence on the whole body it may favour the progress of the degeneration, or at least it may hinder any approach to functional compensation. In any case the adoption of specific treatment in tabes as in other spinal lesions requires great caution. Especially in the case of the administration of mercury the patient must be carefully and constantly watched. And our experience certainly does not justify us in neglecting at the same time the other remedies which lie to our hand. Baths and electrical treatment not only form most valuable adjuncts to an antisyphilitic course, but often give very good results where the latter used alone has failed or proved harmful.*

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* Löwenfeld. Ueber Spinallahmung mit ataxie. Archiv. f. Psychiatrie, Vol. XV., part 2, Case II.

Among the other drugs that are employed, strychnine may first be alluded to. In consideration of its distinctive effect on the cord it was formerly very much used for spinal paralysis, though generally without success. It is not difficult to explain this. It has no resolvent effect on the inflammatory and degenerative changes in the cord, and its physiological property of increasing the reflex irritability permits of only a very limited therapeutic application. Latterly, therefore, physicians have been somewhat sparing in their use of it, and rightly so; and though recently De Cerenville[87] claimed to have attained extremely good results with it in myelitis, tabes, and bulbar paralysis, and Petrone[88] in infantile paralysis, and though Eulenburg[89] has been putting in a word for it, yet I suspect those things will not alter the general opinion. Strychnine seems mostly suited for those cases in which active morbid processes have come to an end, and where we have still to overcome some functional inhibition in the conducting paths. Examples of this are found in conditions of old-standing motor weakness, pareses of the bladder or rectum, sexual debility, and so forth.†

The therapeutic reputation of phosphorus in these diseases has fared still worse. It was first applied by Delpech, in 1863,

* A case recorded by Pusinelli,[85] of Leipzig, is very interesting and instructive in this connection. The case was one of locomotor ataxia with a history of two attacks of syphilis. Besides the tabes there were various other lesions undoubtedly syphilitic—syphilitic lupus on the forehead, cutaneous gummata over the back, swelling of the testicle, and indolent swellings of all the lymphatic glands. With very energetic specific treatment—mercuric inunction, and between 35 and 40 grains of the iodide daily—the lesions over the forehead and back almost completely recovered, and the swelling of the testicle diminished very much. At the same time, however, the disease of the cord got worse. Warm baths were tried for the latter, but also with unfavourable result. Improvement followed the use of nitrate of silver and the application of the galvanic current to the back. Lehmann (Rehme-Oeynhausen) has recorded the following: A man 31 years of age, with a history of syphilis years before, was treated with large doses of iodide and steadily got worse; complete recovery followed a four weeks' course of thermal baths in Rehme with galvanisation of the back and small doses (12 grains daily) of iodide of sodium.

† Strychnine is still largely employed in optic atrophy of spinal origin, and in these cases is generally given subcutaneously. According to Michel[92] this treatment has hitherto proved quite useless, and my own limited experience leads me to the same conclusion.

for some forms of toxic paralysis, and later, in 1868, it was recommended by Dujardin-Beaumetz in locomotor ataxia. But the latter, in his most recent statement[90] on this subject, acknowledges that he has never seen recovery from tabes under the use of phosphorus, but only improvement, and even with regard to this improvement, that it is anything but certain whether it is to be attributed to the phosphorus, When this is the state of matters, I think we had better leave so doubtful a drug alone.

Ergotin and atropin cause, according to Brown-Sequard, narrowing of the vessels of the cord; they should, therefore, very suitably be employed in hyperæmic conditions. I confess I have never been able to note any remarkable result from the use of either of them. Ergotin has recently been particularly recommended in several quarters (Hammond, Benedict, Strümpell) for posterior sclerosis. Grasset,[91] however, has drawn attention to the fact that this treatment is not unattended with dangers. He had under observation one case of tabes in which paralysis of all the four extremities and of the voice occurred under the use of ergot; these disappeared when the drug was omitted.

All the other agents which have been recommended here and there for affections of the cord—quinine, iron, arsenic, conium, veratria, curara, calabar bean, chloride of gold, and sodium—call for very little remark. Quinine and iron may now and then be used for symptoms. Arsenic is recommended by Gowers[93] in tabes. The value of the rest is more than problematical. In cases where there are indications of spinal irritation, pain, spastic symptoms, increased sexual excitability, the bromides are frequently used with success. The same holds good of narcotics; their continued use was formerly often an unavoidable evil, but happily we can now replace them largely by antifebrin and antipyrin. These two last-named drugs have been unquestionably a distinct addition to our armamentarium. No doubt they have never proved to be of lasting service for the structural lesions in any case of organic disease, but they are extremely valuable from a symptomatic point of view. In the treatment of the lightning pains which are often so excruciating, of severe girdle pains, of such spastic symptoms as cramp of the bladder, and of the various forms of crises, rectal, laryngeal, &c., they surpass every remedy we at present possess with the exception of the narcotics. Their usefulness in eccentric pains is particularly evident when these occur in regular attacks. From my own observations I should say that, practically, both drugs are the same in their effects, though in some cases antipyrin may do better, in others antifebrin. I generally order the two together, giving a powder containing twelve grains of antipyrin and four of antifebrin three or four times a day. By the introduction of these two remedies salicylate of soda has been superseded, and the ether spray, which has been employed in France for the relief of lightning pains, might now also be considered superfluous.

The external application of liniments is a mode of treatment in which at present there is very little faith in many quarters. But the scepticism has been carried rather far. I believe from the results of my own experience, both clinical and experimental, that we may beneficially employ friction with spirituous and aromatic substances in spinal disease. Through the gentle stimulating effect on the cutaneous nerves we can influence the nutrition and irritability of the cord, and in certain circumstances favourably modify its morbid conditions. Of course we are not to hope for any speedy or brilliant results from this procedure. On the other hand, I am very much more distrustful of the value of sedative and narcotic liniments. We are constantly inclined to take refuge in them when dealing with spinal pains; but these pains recur again and again, and usually—not to say regularly—the narcotics leave us in the lurch at the time when they are most urgently needed.

V.—*Orthopædics, Gymnastics, Massage, and the application of Rarefied Air.*

The art of orthopædics has not been turned to account in the treatment of spinal disease as far as it might be. Most use has been made of it in the paralytic conditions of the lower extremities in children from anterior poliomyelitis; apparatus have also been successfully applied for the vertebral and joint lesions in locomotor ataxia. And recently the endeavour has been made in the latter disease by means of suitable supports to improve, or, it may be, to restore the power of walking when the ataxia has become very bad. These attempts are worthy of note, and no doubt in many cases of old-standing spinal paralysis in adults the walking could be improved in a similar way.

Gymnastics—both the simple German chamber-gymnastics and the so-called Swedish gymnastics—may be advantageously used in conditions of motor weakness with or without atrophy. They are mainly useful, of course, when the active morbid process which is the cause of the condition has practically come to an end. I have lately employed them in a case of hereditary ataxia for the disturbance of co-ordination in the lower extremities; the patient's gait was improved thereby.

Massage supplements gymnastics in certain respects, as it may be used in those cases where there is not sufficient power of movement to render possible a course of active gymnastics. When properly carried out it can no doubt exercise a marked influence on the nutrition and functional capacity of the muscles. The amyotrophies form the most favourable field for its application, but it has been tried with success even for the anæsthesia in tabes (Schreiber[94]).*

Lastly I must here mention the application of rarefied air by means of Junod's boot (Lyman[95]), which has been used during the last few years for the treatment of the motor disorders in tabes. The success of the method, the improvement in the nutrition and function of the muscles, the diminution of the sensory disorders, &c., make it extremely desirable that we should have a further trial of it, particularly in amyotrophies.

VI.—*Stretching Procedures, Nerve-vibration, and Hypnotism.*

One of the methods next to be described has been the subject of a great deal of writing, almost of a whole literature—I mean nerve-stretching. We know the enthusiasm with which this operation was taken up after the wonderful reports which Langenbuch gave of it, and the hopes that were cherished for the multitude of spinal cases that had, up to that time, been without a remedy. But a short time seemed to elapse, and the treatment of organic disease of the cord passed wholly over into the hands of the surgeon. Yet our expectations, as we know now from an abundant experience, were bitterly disappointed. Of the huge number of cases operated on, not one was cured. It cannot be denied that a certain number improved, and in respect of some of the symptoms improved considerably, but in many of these cases the ground that had been gained was once more lost. And in a far larger number the operation had either a negative result or was followed by more or less distinct deterioration in the condition of the patient. Lastly, there were not a few cases in which the operation caused death, either through something going wrong with the wound, or through lesion of the spinal cord.

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* Rossbach says (Lehrbuch d. physikalischen Heilmethoden, 2 Hälfte, 1882, p. 495), "Only those diseases of the nervous system that are of peripheral origin can be treated by massage," but this opinion, as is evident from what has been said above, is quite untenable. In cases of atrophic spinal paralysis I have repeatedly seen massage prove useful in the stage of convalescence. And Berglind (Petersburg. Med. Zeitsch., 1874, N. F. 5, Heft.) has had good results from it in some cases of progressive muscular atrophy where the disease was not far advanced. In tabes, I have observed, it sometimes improves distinctly, though only for a time, the power of walking.

From these facts it will be sufficiently understood that nerve-stretching as a remedy for chronic disease of the cord has latterly been generally rejected. In a small number of instances the so-called "bloodless" nerve-stretching has been tried. But again experience teaches that, even in the most favourable case, we can expect from this nothing but some improvement in individual symptoms. And it is by no means so certain, it appears to me, that it is so devoid of danger as some represent —we must remember that the other operation to begin with was represented as quite a harmless proceeding. I believe, however, that a warning is here scarcely necessary: I rather suspect that both kinds of nerve-stretching—it may be without sufficient ground—are, in the treatment of diseases of the cord, among the things we have done with.*

Two other stretching methods have been suggested. The stretching of the spinal cord was proposed by A. Hegar,[97] of Freiburg, as a substitute for nerve-stretching. The occasion was the observation by this well-known gynæcologist—though it had been frequently observed before—that certain disorders which he thought originated in the lumbar cord, but which are frequently associated with sexual troubles, are produced by marked bending of the spine forwards. To the observation

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* Benedict[96] is the only physician of any importance who has latterly continued to express himself in its favour as a remedy for tabes. It looks as if in this matter Benedict would remain the voice of one crying in the wilderness.

Hegar added the reflection that what could do harm might in certain circumstances do good. And starting from some anatomical investigations of his own, he contrived a method for producing extension of the cord in the living subject, which consists essentially in this, that either the head and thorax are passively flexed towards the lower extremities, or the latter, kept extended, are flexed towards the head and thorax. This is to be done without an anæsthetic, and the exercise of undue force is to be avoided. I cannot call Hegar's idea a happy one. From several observations of my own in the matter, I believe that all that is allowable and of any use in his "spinal extension in the living subject" can be attained by the use of chamber gymnastics. And in consideration of the very great differences in different individuals in the elasticity of the inter-vertebral connections,* we can by no means exclude with Hegar's method the danger of injuring the spinal column, or even—through tearing of vessels particularly—of injuring the cord and its membranes.† We are still quite in the dark as to what the method has specially accomplished. Motschutkowsky,[98] a Russian physician, tried stretching the body by suspending the patient. Among fifteen cases of tabes thirteen are said to have improved in respect of pains, paræsthesiæ, ataxia, and muscular strength, while the remaining two became worse under the treatment. In some other cases of disease of the cord—diffuse myelitis, insular sclerosis, &c.—Motschutkowsky gained no result. In tabes he recommends suspension for ten minutes three or four times a week. He thinks the therapeutic effect is to be referred to the stretching of the nerves and arterial trunks; this produces a rise of blood pressure in the cord, and a consequent acceleration of the circulation. In spite of these physiological arguments there are probably few physicians who will be found ready to continue Motschutkowsky's trials.‡

Some physicians have seen good done in several forms of neuralgia from the effects of weak mechanical vibrations,[*] and this may have induced Mortimer Granville[99] to try "nerve-vibration," and to recommend it as a special mode of treatment in some diseases of the spinal cord, especially locomotor ataxia. He obtains this vibration by means of an instrument called a "percuteur," which is set in motion by clockwork or electricity. It is quite impossible to come to any conclusion at present on the value of this method.

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* Let us call to mind, for example, the performances of some circus clowns and contortionists, and compare with these the mobility of the spinal column in one who has had no athletic training.

† Hegar himself remarks: "The proceeding is not so harmless as it may appear at first sight. At any rate, my experience of it, both in the healthy and in those affected by disease, though not yet of course very large, has convinced me that it has a very distinct effect."

‡ This was written in 1888.—*Tr.*

It can excite no surprise that in our time hypnotism also has been tried. The only thing that deserves notice in this connection is Bernheim's[100] (Nancy) account of the results of the application of his suggestion method. In one case, which he calls "sub-acute diffuse myelitis of the anterior columns" (the diagnosis, to my mind, is not certain), he had considerable improvement under its repeated application. In several cases of ataxia he succeeded in overcoming for a time the lightning pains, gastric crises, and tenesmus of the bladder. In one of the patients the walking was for some time very much better, and the man who previously had been unable to stand upright was able to go without a stick.[†] In a number of cases of spastic paralysis and multiple sclerosis, he obtained a diminution, lasting for a longer or shorter time, of the exaggerated tendon reflexes and the contractures. But in all the success was merely temporary. He acknowledges himself, quite plainly, that the course of lesions like locomotor ataxia and multiple sclerosis is not to be stayed by hypnotic suggestion. From such indications we can hardly assume that hypnotism has any particular part to play in the treatment of organic disease of the cord. The temporary results which are obtained may probably be, for the most part, got at in another way. The so-called functional diseases, however, form a rich soil for this method, and it seems particularly suited for certain very troublesome symptoms, such as back-ache, seminal emissions, &c.

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[*] For example, Dr. Boudet, of Paris, has treated neuralgia with great success by the transference of the vibrations of a tuning-fork to the painful spots in the course of the nerve.

[†] The fact is not without interest that I have obtained a like result in several patients by applying the faradic wire brush to the outer border of the foot. There could be no question in these cases of any "suggestive" influence, as this result was quite unlooked-for, both on the part of the patient and on my own. The patients themselves drew my attention to the circumstance. Löwenfeld, Investigations in Electrotherapeutics, p. 69.

VII.—*Regulation of the Mode of Life.*

No organic disease of the cord can be cured by dieting, yet the regulation of the daily life plays a very important part in the treatment.

The food should be, on the whole, nourishing and easily digested, though we must avoid anything like fattening-up, especially in cases where the ability to move about has already suffered; with any increase in the bodily weight these patients would become still more helpless. The consumption of alcohol must always be moderate. In the matter of clothing the chief object is to guard against getting cold or wet; looking after the skin and regular washing with tepid or cold water can also do a good deal in this direction. But the most important matter of all is as large an allowance as possible of fresh air. The benefits which even old cases frequently gain by a residence during the summer months at some spa or climatic resort are very largely to be referred to this particular influence.* This is the reason why many patients who do not require much looking after or nursing find it so much to their advantage to spend the winter in the South; and there is nothing yet known of any specially favourable effect otherwise of one or other of these southern resorts. The going about requires to be attended to. As bodily movement alone can keep the muscles in good condition, a certain amount of it must be secured according to the ability of the patient. On the other hand, we must not hesitate to forbid walking altogether if we find that it is carried on only with an effort, and that there is danger of falling.

Some physicians speak favourably of the influence of complete rest in bed for a long time in some forms of spinal disease. Donkin,[101] for example, reports undoubted success in some cases of spastic paralysis, whom he kept in bed for several months. Brower[102] recommends for the initial stages of tabes that the patient should be kept in bed for a long time lying on his back. In hospitals particularly it has been noticed that cases of tabes coming in in a state of exhaustion do very well with lying in bed for a while. Donkin's cases just referred to were those of persons in whom the disease had been brought on by muscular strain. But, on the whole, in the case of individuals who are capable of going about, a moderate amount of movement out of doors is preferable on account of the benefits both of the fresh air and of the muscular exercise.

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* Sea-voyages are also recommended by English physicians.

The mental occupations must be looked after, and any intellectual strain avoided.

Sexual intercourse must always be restricted, and in many cases forbidden altogether. The regulation of the bowels requires attention; most spinal cases are inclined to constipation. This is best treated by suitable dietetic methods, and where these are not sufficient, by drugs, enemata, or massage of the abdomen.

APPENDIX.

Treatment of Cystitis and of Bedsore.

THE occurrence of cystitis or bedsores in the course of chronic disease of the spinal cord is justly regarded with great dread. Many patients suffer all the year round from these complications and their consequences, and they immensely increase the suffering in a class of cases where there is generally quite enough of it already. It must therefore be one of our first objects to guard against their occurrence, or at any rate to put it off as long as possible.

As the cause of cystitis is generally stagnation of urine in the bladder, our first business is to see to the regular and complete evacuation of the latter. Vesical weakness, accordingly, when present must be treated as early and as thoroughly as possible; and the most effective means of doing this is undoubtedly a suitable application of electricity. If this does not succeed in removing the weakness, or if it succeeds but imperfectly, we must try mechanical means, such as pressing on the bladder, kneading the abdomen, placing the patient in the upright position, or causing him to sit on the night-stool. Should these measures fail, we must resort to regular daily catheterisation. The instrument must be disinfected as carefully as possible on each occasion of using, otherwise the cystitis which it is intended to ward off will be produced in its very worst form. If there is catarrh of the bladder internal remedies are not much to be trusted to. The most of them, such as salicylic acid, benzoic acid, boric acid, chlorate of potash, tannin, uva ursi, but especially the balsams, cannot be continued for any length of time: they disagree with the stomach, and disorder both the appetite and digestion. Mineral waters such as those of Wildungen, Vichy, Ems, &c., are more harmless in this respect, and in the milder class of cases may be continued for a long time. If the urine contains mucus and pus in abundance, in other words if the cystitis is severe, the only way of making a distinct and permanent impression upon it is by regular washing out; that is best done by means of the double catheter, with a three or four per cent. solution of boracic acid.* Under this treatment I have seen severe purulent catarrh reduced to a minimum. At the same time of course any imprudence in diet, such as indulgence in beer, new wine, or highly-spiced dishes must be guarded against.

As regards bedsores in these diseases, v. Gudden's well-known view was that they were the results of defective nursing alone, and that they had nothing to do with trophic nervous disorders. Although this goes rather far,† yet there is no doubt that by proper care we can do a very great deal to avert the complication.

The parts most exposed to the risk must be carefully watched and protected from continuous pressure by means of air or water cushions, and frequent changes of positions; scrupulous cleanness must be adhered to, and the skin regularly washed with a solution of spirit to strengthen the tone of the cutaneous vessels; disinfecting solutions followed by the application of powder should also be used. If there is a slight bedsore it is sufficient to dress it with zinc or boracic ointment; if there is furuncular action mercurial carbolic plaister should be used, and of course the measures enumerated for prevention should now be enforced with increased rigour. When there is extensive gangrenous bedsore the treatment must be carried out strictly according to modern antiseptic principles; these principles have many a triumph to record even on ground so unfavourable as this is, and I have repeatedly seen cases of bedsores with undermining and extensive sloughing where healing was finally attained by careful and persistent antisepsis.

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* Rosenthal[163] recommends for washing out, on account of its antiseptic property, a solution of four drops of nitrite of amyl in about a pint of water.

† Charcot's *decubitus acutus* is unfortunately no fable; I have repeatedly seen it arise in circumstances where there could be no question of any continuous pressure on the skin.

B.—TREATMENT OF FUNCTIONAL DISEASES OF THE CORD—SPINAL IRRITATION.

In addition to the organic lesions of the cord, the functional affections as they are called are of no small importance. The commonest and practically the most serious is spinal neurasthenia (spinal irritation, myelasthenia), and I shall content myself in this section with dealing with the treatment of this alone; that of the rest in so far as it is not determined by these causes (as in the case of intermittent spinal paralysis) is essentially the same as in neurasthenia.

In the slighter forms of this affection, in those forms especially which are so frequently seen in young people as a consequence of sexual error, all that is required in addition to removal of the cause, regulation of the mode of life, and the avoidance of mental and bodily strain, is the application of the galvanic current to the back for a few weeks, either with or without some mild hydropathy. Residence in the country or among the hills at the proper time of the year, bathing in lakes or rivers when the water is not too cold, and in the sea in the case of those in fairly vigorous condition—all these also are very serviceable measures.

The more severe forms are not so easily dealt with. These are the instances when, with an inherited neuropathic tendency to found upon, we have super-added the influence of some severe strain, prolonged over several years, as, for example, from mental or bodily exertion, or from sexual excesses. They call for very careful observation on the part of the physician; for, though life is not endangered, the capacity of the individual for work is very seriously interfered with, and may be destroyed altogether, while in many ways his existence is made a burden to him. The treatment of such cases not infrequently requires tact and patience of the highest order. The removal of the cause, so far as this is possible, is of course the first object. The importance of attaining this, however, may be over-estimated. I have explained elsewhere[104] that if the condition lasts long enough, the morbid changes in the nervous system display a tendency to disassociate themselves from their causes, so that the removal of the latter may not check the continuance of the affection. This particularly requires to be borne in mind where we have disease of the genital organs as one of the causes, *e.g.*, chronic urethritis in men, or change in the form and position of the womb in women. If we do nothing else than attend to these, it is quite possible that our endeavours may not only prove ineffectual to cure the neurosis, but may even leave it worse than they found it.

Drugs take a subordinate position among the remedies at our command, though some physicians, especially in America, lay great stress on them, and have hit upon some very complicated formulæ. Those mostly used are nux vomica and its preparations, arsenic, tonics like iron and quinine, and the bromides. With none of them can we count on anything like astonishing success, to say nothing of recovery. From my own experience I should say that nux vomica and arsenic were the least trustworthy of the whole of them. Tonics are useful as adjuncts to other modes of treatment, but by themselves they hardly deserve mention. Bromides are relatively the most effective. They only suit those cases in which there is a markedly irritable condition, indicated by pain, very troublesome paræsthesiæ, sexual excitement, &c., and must be given in rather larger doses than usual—60 to 90 grains daily. Derivatives are of no particular use for the general condition ; they are best employed to combat symptoms, especially the backache which is so much complained of, but very commonly they only give ease for a time. The most valuable remedies we at present possess are undoubtedly electricity and hydro-therapeutics, and in Germany, at any rate, we are coming more and more to recognise this. Of the various ways in which electricity may be applied, galvanisation of the back is perhaps the best. Applied with the necessary care and persistence, it unquestionably gives very good results in a great number of cases. Current densities of moderate strength, such as $\frac{\text{2–5 ma.}}{\text{50 square cm.}}$, should be used, the duration of the sitting should be gradually lengthened, and the part of the cord most affected (generally the lumbar portion) should receive special attention. On the other hand, it is often good practice to treat the periphery in this way, such as the lower extremities and the sexual organs. In many cases we get equal success from general faradisation, applied according to the method of Beard and Rockwell ; indeed, now and then this gives distinctly better results. A number of years ago I explained in a little publication[105] the special excellencies of this method, and I content myself on the present occasion with pointing out that it is particularly useful in those cases of myelasthenia in which the motor activity is very seriously affected. Faradic baths have been recently recommended in various quarters (Ischewsky,[106] Stein,[107] Eulenburg,[108] Lehr,[109] &c.) as a very convenient way in which to apply general faradisation. I do not doubt in the slightest that the reports of the beneficial effect of these baths are correct, but from my own experience I can hardly think it the case that we may look to them for all the good that we get from general faradisation, according to the method of Beard and Rockwell. Statical electricity has been tried both by myself and others within the last few years; there is nothing particular to say about it, and further observations are necessary before we can form any conclusion as to its value.

Of hydro-therapeutic methods, half-baths, at a temperature of 77°—86° Fahr., followed by a pail douche with the water at a somewhat lower temperature, or the rapid wash-down, or the wet sheet, followed by a wash-down—all these may be employed with advantage. With the two latter methods the water can —as the treatment goes on—be used some degrees lower than the lowest limit permissible in organic disease. Individuals in fairly vigorous health can bathe in lakes or rivers provided the temperature is at least 72°. Those who are in a weakly condition, and who are very susceptible to temperature, should be recommended to use brine baths of from 89° to 93°, or indifferent thermal baths; and, if there is distinct anæmia, chalybeate baths. Sea bathing, as a rule, is only to be used afterwards; the same holds good of mountain air, so far, at any rate, as the enjoyment of this is to interfere with the continuance of the hydro-therapy. In spite of the fact that mountain residence usually exerts a very beneficial influence on the general condition of the patient, it does not suffice by itself, as a rule, to effect a permanent cure. In certain cases massage may be used in support of other methods of treatment; it is particularly serviceable in weakness of the legs and back, and in some kinds of backache. The massage may be performed in the ordinary way, or it may be associated with general faradisation—faradic massage; in the latter case we use a particular instrument, *e.g.*, the "*massirrolle*," contrived by Dr. Stein of Frankfurt. The one pole of an induction battery is brought into connection with the instrument which is used for the massage of the various parts affected, while the other pole is connected with some indifferent spot on the body. Massage also, as is well-known, plays an important part in the Weir-Mitchell treatment, and in cases where the body is very much reduced we often get results by the help of this latter method which we can attain to in no other way. Whatever kind of treatment we may choose, it is absolutely necessary to regulate the whole mode of life. The diet must be simple but nutritious; alcoholic liquor must be taken in great moderation, the patient must be a good deal in the open air, and moving about as much as his strength will permit, and he must have only moderate mental occupation. Sexual intercourse must be limited, and even for a time forbidden in some cases, and all causes of sexual excitement must be avoided.

There are one or two remarks I should like to make in concluding. Not much more than twenty years have passed away since our master, Romberg, was ready to stand by his famous saying in regard to the fate of those affected with tabes: "There is no prospect of recovery for patients with this disease; the staff has been broken over each." The saying was no doubt a perfectly just one at that time, but fortunately has ceased to be true for a number of years. Recoveries from locomotor ataxia have been recorded by thoroughly trustworthy physicians, and I know of several cases myself, even in those who have not had syphilis. And, in a similar way, in a great variety of organic affections of the cord, treatment has been attended by distinct success, improvement, and even recovery. But these facts must not lead us to over-estimate our abilities. Encouraging as the advance is which has taken place in the treatment of these diseases in the last twenty years, we must yet allow that we are only just setting out, and that almost all the way still lies before us. But just on that account it is of the utmost importance that, in our anxiety to press forward, we should not get into any false track. There was a time when every affection of the spinal cord was attributed to excesses, and the poor sufferer, in addition to his disease, had to contend with this odious prejudice. At the present day, again, many are inclined to refer the majority of them to microbes and toxines, and consequently they expect that any future advances in our therapeutic resources will depend largely on the results of ætiological investigation. It may not be superfluous to remark that the progress of the last twenty years has been made not through increase in our knowledge of the causes of these diseases, and, in particular, not through bacteriological investigations. It is owing to the immensely increased precision and care in the application of hydro- and balneo-therapeutics, and even more to the advances in electro-therapeutics. But neither of these two classes of remedies can exercise any direct influence on bacteria or toxines. Again we must observe that an advance in our knowledge of causes by no means coincides with an advance in our treatment. The discovery of the tubercle and cholera bacilli has not been attended by the discovery of any remedy which can destroy these bacilli in the living body. This appears to me to show distinctly enough that, however large our expectations may be in regard to what we are yet to gain from a study of causes, we should keep our attention constantly fixed on the development of our present empirical treatment; at the same time we must be always on the watch for some general principles to guide us outside these ætiological ones of which I have spoken.

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